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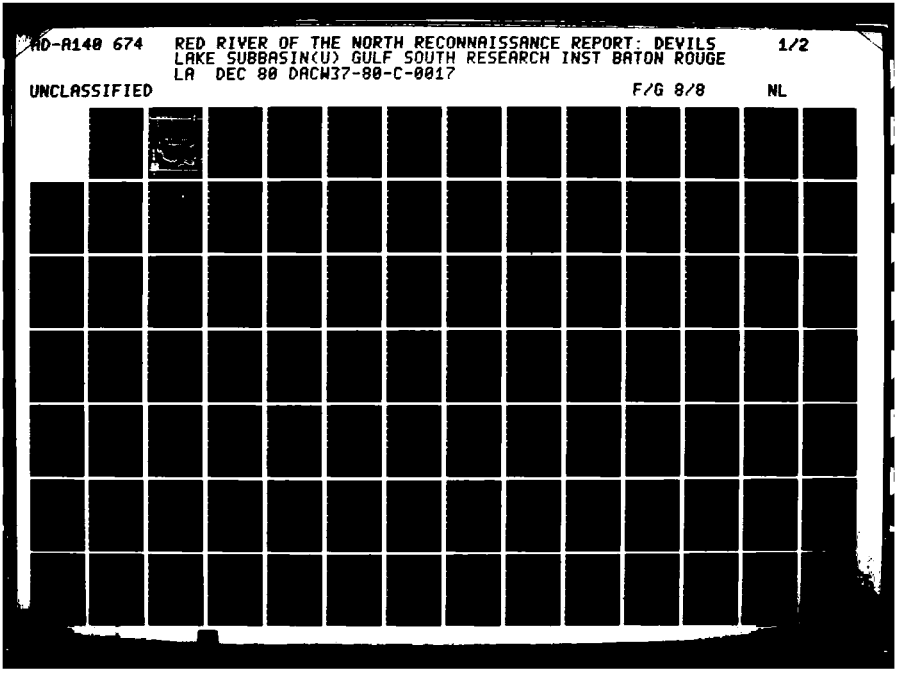

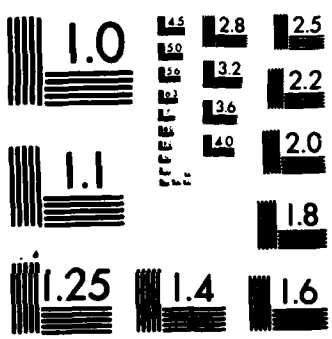


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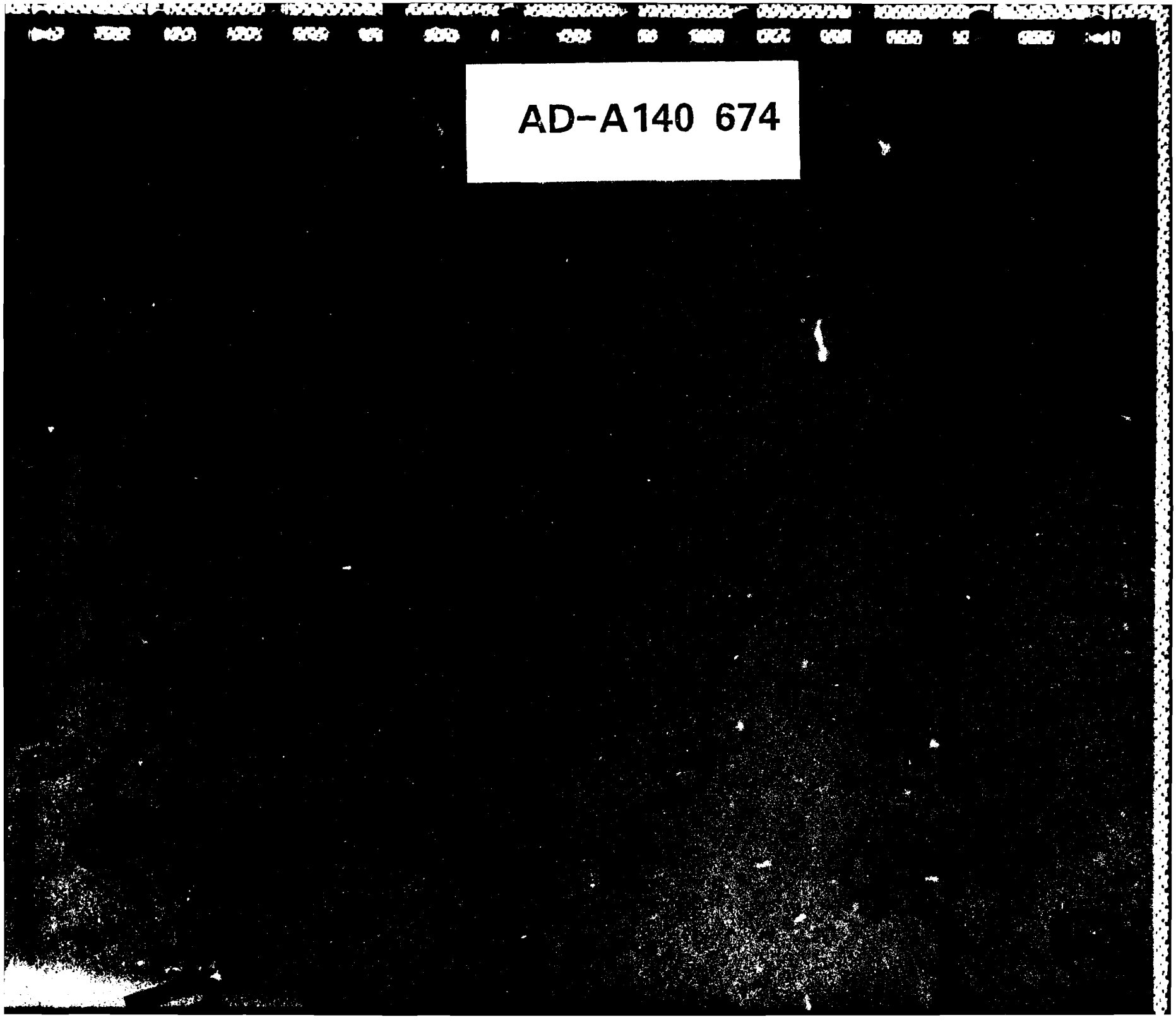

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin.

The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and

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problems, to determine priorities for immediate and longrange action, and to identify the capabilities of various governmental units for implementing the actions.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

The Devils Lake subbasin is located in the northwest corner of the Red River Basin, and it encompasses portions of nine counties in North Dakota. Flood damages in the subbasin normally occur in March through May as snowmelt runoff overflows the banks of streams and coulees, innundating thousands of acres of cropland. Blocked culverts, inadequate bridges and graded highways contribute to the subbasin's flood problems.

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# RECONNAISSANCE REPORT: RED RIVER OF THE NORTH BASIN, DEVILS LAKE SUBBASIN



Prepared for:

U.S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North Study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin.

The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and problems, to determine priorities for immediate and long-range action, and to identify the capabilities of various governmental units for implementing the actions.

The Devils Lake Subbasin is a water resource planning unit located in North Dakota in the northwest portion of the Red River Basin. This report describes the social, economic, and environmental resources of the subbasin, identifies the water-related problems, needs, and desires, and suggests measures for meeting the needs, particularly in the area of flood control.

The report was prepared almost entirely on the basis of secondary information. However, some telephone contacts were made to verify information and to acquire a more complete picture of local conditions. To date, the only comprehensive report available on the subbasin is the Devils Lake Basin Study, volumes I, II and III, which were prepared in 1976 for the Devils Lake Advisory Committee. Other published sources on the subbasin include:

1. Flood Control Reconnaissance Report, Devils Lake, North Dakota, which was prepared in 1980 by the St. Paul District Corps of Engineers. It provides an overview of flood problems in the subbasin.
2. Work Plan for the Starkweather Watershed which was prepared by the U.S. Soil Conservation Service and describes the proposed flood protection plans for the watershed.
3. Economic Impact of Flooding on Agricultural Production in Northeast Central North Dakota, a report by the North Dakota Agricultural Experiment Station, which was prepared in 1977 as a Volume III of the Devils Lake Basin Advisory Committee Study Report.

In addition, the subbasin received partial coverage in the Souris-Red-Rainy River Basins Comprehensive Study, which was published by the Souris-Red-Rainy River Basins Commission in 1972, and in the Red River of the North Basin Plan of Study, which was published by the St. Paul District Corps of Engineers in 1977.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

# II. DESCRIPTION OF STUDY AREA

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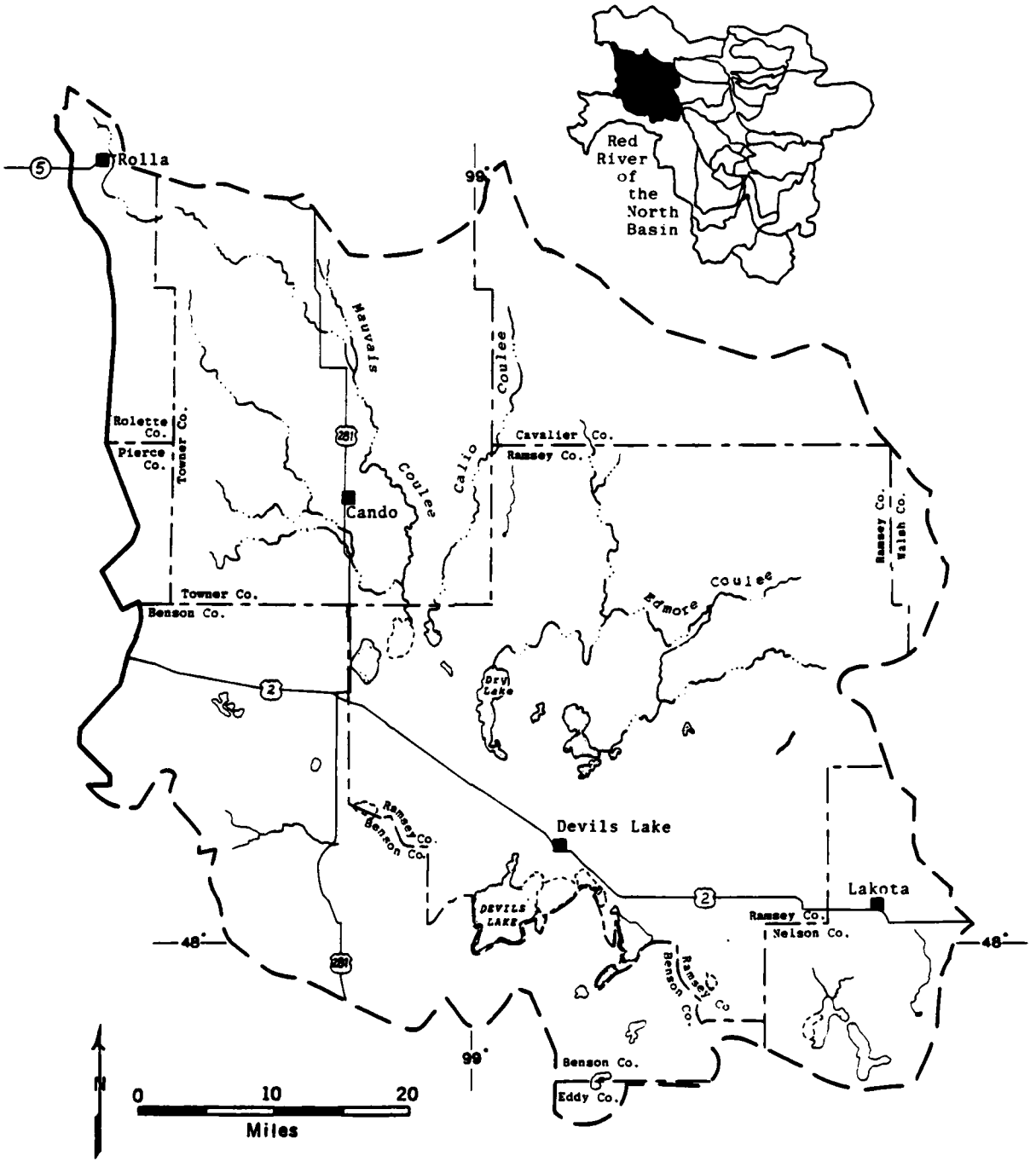
The Devils Lake Subbasin (Figure I) is located in the northwest corner of the Red River Basin, and it encompasses portions of nine counties in North Dakota. The subbasin is bordered to the north by the Pembina Subbasin, to the south by the Sheyenne River Subbasin and to the east by the Park, Forest and Turtle rivers subbasins.

The subbasin is a closed drainage system about 3,580 square miles in extent. The natural drainage of the region includes numerous streams and coulees, some of which interconnect with the many shallow lakes which are characteristic of the subbasin. Surface water run-off in the subbasin drains north to south, with most of the runoff eventually flowing into Devils and Stump lakes.

Physiographically, the subbasin lies well within the Central Lowlands Province, an area of glacial drift and lacustrine plains that formed during the last ice age. The topography of the region varies from steeply rolling glacial drift with a slope of over 15 percent, to the flat and featureless glacial outwash plain which has a slope of only three percent. The entire subbasin is dotted with numerous potholes and small shallow lakes which are natural reservoirs for surface run-off. These lakes, together with the wetlands of the subbasin, enhance its regional importance as a migratory waterfowl staging area.

Approximately 71 percent of the land is devoted to crops, and another 20 percent is used for pasture. Forest acreage is small and is generally confined to the Devils Lake area. Flood damages in the subbasin normally occur in March through May as snowmelt runoff overflows the banks of streams and coulees, innundating thousands of acres of cropland. Blocked culverts, inadequate bridges and graded highways contribute to the subbasin's flood problems. Recently, the water level in Devils Lake itself has risen to such a degree that adjacent urban and rural areas are threatened by the historic reversal in the lake level.




Source: Gulf South Research Institute.

Figure I. DEVILS LAKE SUBBASIN

# III. PROBLEMS, NEEDS, AND DESIRES

## III. PROBLEMS, NEEDS, AND DESIRES

The primary water-related problems, needs, and desires in the Red River Basin are flood control, fish and wildlife conservation and enhancement, recreation, water supply, water quality, erosion control, irrigation, wastewater management, and hydropower. Various water-related problems, needs, and desires have been identified for the Devils Lake Subbasin in previous planning reports on the basis of analysis of conditions and public and agency comments. The list of problems, needs, and desires for the subbasin is the same as the list for the Red River Basin as a whole. Each problem is discussed separately below, with an emphasis on flooding problems.

### Flooding Problems

#### Nature of the Problems

Flooding occurs in the subbasin as a result of snowmelt in March or April and sometimes in early May. Frequently aggravated by rains of high intensity, these floods force delays in planting operations that cause significant reductions in crop yields. Given the short growing season, if water stays on the land too long, it may be impossible to engage in planting operations. When the numerous small depressions that characterize the subbasin are wet, it becomes impractical to operate large machinery on the irregular pattern of associated dry areas.

Significant flood damage in the subbasin also results from high intensity summer rains. Flooding caused by rainfall that exceeds channel capacity occurs from May through September. Wetland drainage operations contribute to runoff flows and, in some cases, result in sheet flooding, causing damage to mature crops. Grain crops can be destroyed by several hours of inundation, while other crops may suffer reduced yields and lower quality.

Topography has an influence on flooding problems in the subbasin. The watershed's principal features are the level to gently rolling ground moraine in the headwaters to the nearly level ground moraine surrounding Dry Lake. Potholes and small lakes dot the entire area, retaining local runoff. The more steeply undulating surfaces of the uplands contain the greatest number of wetlands.

Poorly drained clay loam soils derived from the glacial drift are characteristic of wetland areas, and cause water to remain for long periods of time. Well-drained loams are the principal soils of the uplands, but the heavier soils of wetland areas are frequently flooded.

Southward movement of floodwaters through Dry Lake towards Devils Lake is blocked on the southern and western reaches by end moraine deposits. When the sweetwater chain of lakes (including Sweetwater Lake, Morrison Lake, Dry Lake, Lac Aux Mortes and Lake Irvine) discharge one into the other, thousands of acres of land are covered by water. This condition constitutes the principal water problem in the subbasin: damage to agricultural crops and land by sheet flooding.

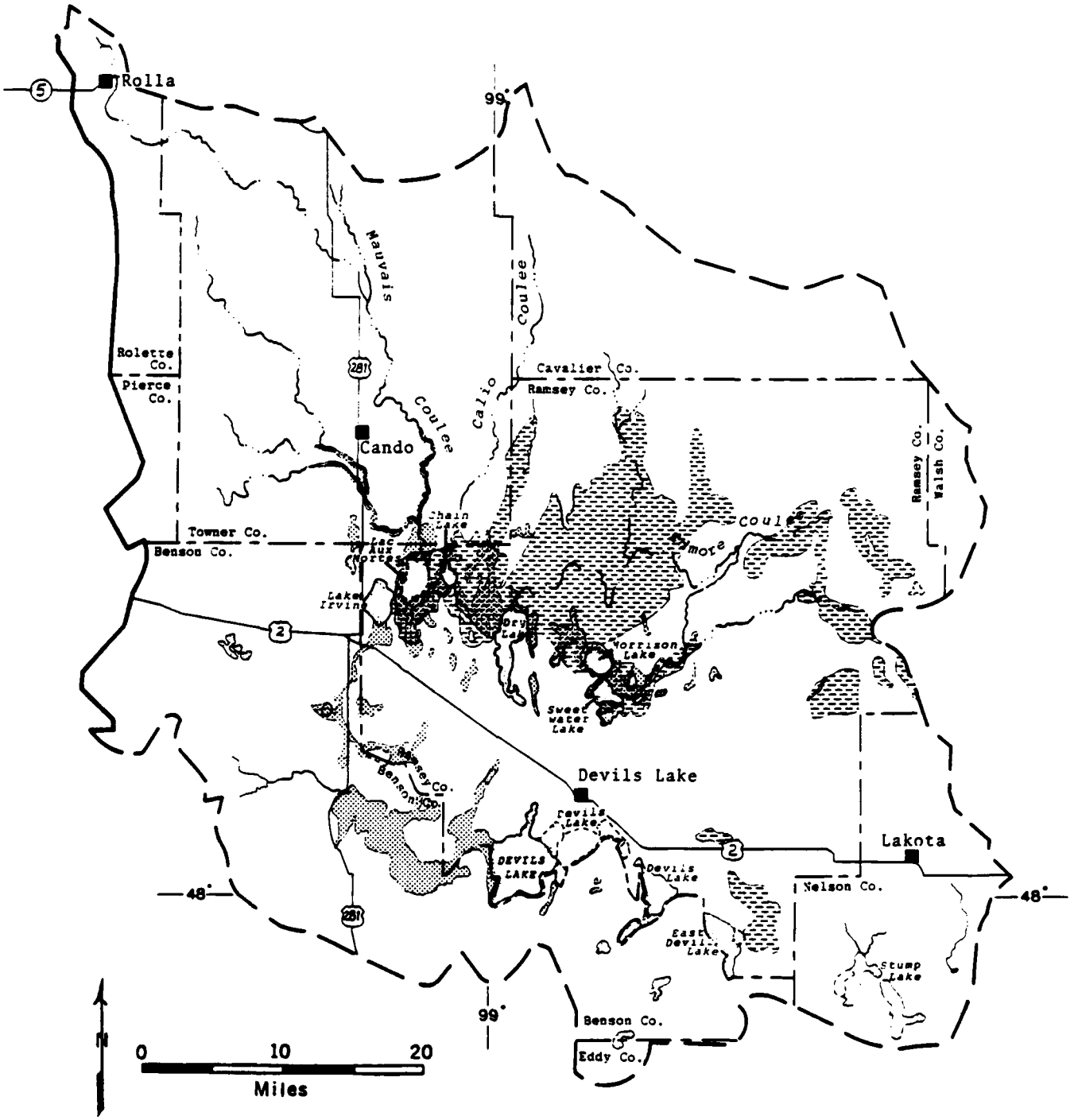
Location and Extent

Figure II depicts the 100-year floodplain for the Devils Lake Subbasin. A number of sources were investigated in order to produce the present delineation. Among these were: (1) U.S. Geological Survey (USGS) Flood Prone Area Maps at 1:24,000 scale; (2) Corps of Engineers photomosaics of the 1979 flood; (3) published secondary sources describing flooded areas; and (4) USGS 7½ minute topographic maps.

The map is thus a composite of available sources supplemented by inferences where necessary. Because the sources were incomplete and based on surveys differing in purpose and accuracy, it should be understood that Figure II constitutes a generalized delineation intended only for general planning purposes. A more complete description of sources and limitations is given in Appendix A.

According to this preliminary delineation, the Devils Lake 100-year floodplain comprises a total of 56,000 acres. Major components include: the Lake Irvine-Dry Lake area, 24,000 acres; the Sweetwater Lake area, 6,000 acres; the Devils Lake area, 22,000 acres; and the Pelican Lake area, 4,000 acres. This delineation represents a known 100-year flood level and is based mainly on interpretation of the 1979 flood photography.

The floodplains of the subbasin consist of broad areas of land adjacent to and between lakes, with isolated areas adjacent to stream channels in the upper reaches subject to frequent flooding. The Souris-Red-Rainy River Basins Comprehensive Study cites a total figure of 130,000 acres as comprising




Source: Gulf South Research Institute.

**Figure II. 100-YEAR FLOODPLAIN AND CTHER FLOOD-PRONE AREAS**

the entire floodplain. The aerial delineation thus accounts for only a portion of this figure. Plate X of Volume 1 of the Devils Lake Basin Study is also shown on Figure II in an attempt to supplement the 100-year delineation shown. This area of 180,000 acres shown in the cross-hatch pattern overlaps with the first delineation to the extent of 18,000 acres. Taking this figure into account, the two delineations total 162,000 acres. Since this figure exceeds the 130,000 acre estimate cited, it is likely that not all of the Primary Flood-Prone Areas are 100-year frequency in extent. The two delineations together do, however, present a better overall delineation than each does on its own.

Flood Damages

The primary areas affected by flooding throughout the subbasin's floodplain are urban, agricultural and environmental in nature. No urban areas are subject to recurrent seasonal flooding in the subbasin. However, there are some urban damages from time-to-time that must be added to the average annual damage figure, and the city of Devils Lake is threatened by rising lake waters.

Present average annual damages in the subbasin are estimated at $2.8 million. This figure accounts for approximately eight percent of the Red River of the North basinwide average annual flood damage total. Urban and rural are the two basic classifications into which average annual damages are divided. Damages to residences, businesses (commercial and industrial) and public facilities (streets, utilities, sewers, etc.) are reported as urban damages. Rural damages are damages to crops, other agricultural assets (fences, machinery, farm buildings, etc.) and transportation facilities. Urban damages account for less than one percent of the total average annual damage figure for the subbasin; rural damages account for over 99 percent.

Urban damages for the subbasin are presented in Table 1. No urban flood damages were reported to have been sustained from the flood events of 1975 or 1979. Average annual urban flood damages in the subbasin are estimated at $2,600. This figure includes $1,300 in residential damages, $1,000 in business damages and $300 in public damages.

Table 1

DEVILS LAKE SUBBASIN, ESTIMATED AVERAGE
ANNUAL URBAN FLOOD DAMAGES
(Thousands of 1979 Dollars)

| Category | Average Annual Urban Damages |
|---|---|
| Residential | $1.3 |
| Business | 1.0 |
| Public | .3 |
| TOTAL | $2.6 |

Sources: Red River of the North Basin Plan of Study, April, 1977; and Gulf South Research Institute.

Estimated average annual rural flood damages are presented in Table 2. No estimate of rural damages was prepared by the St. Paul District for the 1975 or 1979 flood events. Total average annual rural flood damages are estimated at $2.8 million. This figure includes $1.9 million in crop damages, $643,700 in other agricultural damages and $194,000 in transportation damages.

Table 2

DEVILS LAKE SUBBASIN, ESTIMATED AVERAGE
ANNUAL RURAL FLOOD DAMAGES
(Thousands of 1979 Dollars)

| Category | Average Annual Rural Damages |
|---|---|
| Crop | $1,931.2 |
| Other Agricultural | 643.7 |
| Transportation | 194.0 |
| TOTAL | $2,768.9 |

Sources: Red River of the North Basin Plan of Study, April, 1977, and Gulf South Research Institute.

Environmental Concerns

It was pointed out earlier in both the Pembina River and Sheyenne River Subbasin reports that the Devils Lake area represents one of the three most important remaining areas of natural woodlands in the State of North Dakota. The two other areas are the Turtle Mountains in the Souris River Basin and the Pembina Hills in the Red River Basin. Of the approximate 400,000 acres of remaining woodlands in the State as of 1972 (the smallest percentage of woodlands in any of the 50 states), about 252,000 acres of forest were contained in these three areas. These areas are extremely significant now because of the construction and filling of the Garrison and Oahe Reservoirs and the extensive clearing of the major bottomland hardwood formations along the Missouri River between these two lakes. Additionally, about 35 percent of the forests in the three areas have been cleared in the past 20 years; the annual rates of clearing for Cavalier, Towner, and Rollette counties from 1958 to 1967 were 3.6, 3.4, and 0.1 percent, respectively. The forests in these three areas provide high-value habitats for wildlife and for outdoor recreation associated with wildlife, as well as excellent aesthetic attractions (Souris-Red-Rainy River Basins Commission, 1972; U.S. Army Corps of Engineers, 1977).

Table 3 provides data on the woodland acreages remaining in the Turtle Mountains, Upper Pembina Valley, and Devils Lake areas. The table shows that 28,200 acres of woodlands are in public ownership; the remaining 223,800 acres are privately owned and subject to clearing. Although the state provides tax abatements for woodland maintenance, clearing has not been reduced, and the native timber has little market value, which does not provide the landowner with an incentive to save woodlands. The Souris-Red-Rainy River Basins Commission (1972) reported that a ten-year program, involving the State Forest Service, State Park Service, and State Game and Fish Department, could be developed to acquire the remaining woodlands. The State Outdoor Recreation Agency, State Highway Department, and State Water Commission would provide important technical, engineering, and legal assistance.

The information presented above indicates the pressing need to protect the remaining woodlands of the subbasin, since they are extremely significant habitats for wildlife, are important for wildlife-oriented recreation, and are of exceptional aesthetic value.

Table 3

WOODLAND PRESERVATION AREAS IN NORTH DAKOTA

| Area | Existing Woodland (Acres) | Publicly Owned Woodlands (Acres) | Woodlands Remaining to Be Acquired to Assure Preservation of the Area (Acres) |
|---|---|---|---|
| Souris River Basin | | | |
| Turtle Mountain* | 125,000 | 20,700 | 104,300 |
| Red River of the North Basin | | | |
| Upper Pembina Valley | 84,000 | 5,770 | 78,230 |
| Devils Lake Area | 43,000 | 1,730 | 41,270 |
| TOTAL | 252,000 | 28,200 | 223,800 |

*An undetermined amount of acreage in this area falls within the Red River Subbasin.

Source: Souris-Red-Rainy River Basins Comprehensive Study, Appendix J, Fish and Wildlife.

Numerous wetlands and most native prairies have been eliminated in favor of agricultural and other land uses. Cropland accounts for 78 percent (1,787,136 acres) of the total subbasin area, range and pasture for 9.6 percent (219,955 acres), and urban for 2.5 percent (57,280 acres). Wetland drainage is still continuing and is reducing the amount of prime waterfowl habitat. Representatives of the native grasslands are still likely to be found in the areas occupied by the range and pasture land use category; however, they are undoubtedly small in areal extent (Soil Conservation Service, 1969; Upper Mississippi River Basin Commission, 1977; U.S. Fish and Wildlife Service, 1979). These two major habitat types are very productive for wildlife, and in the case of wetlands, provide a variety of other beneficial uses. There is a need to protect, conserve, and enhance where possible these sensitive ecosystems in the subbasin.

The Upper Mississippi River Basin Commission (1977) indicated that problems associated with aquatic biota in the subbasin are related to high concentrations of dissolved solids in Devils Lake and Stump Lake as a result of municipal, industrial, and agricultural pollution. Dissolved solids are also a problem because there is no outlet for the system. The high saline conditions of these two lakes have restricted fishing and other water-based recreation. Recent improvements have occurred in water quality; the waters of Devils Lake have been freshened as a result of wetland drainage into the lake. Devils Lake now supports one of the best fisheries (perch, bass, crappie, etc.) in the state. The North Dakota Game and Fish Department has estimated that 400,000 pounds of sport fish were taken from the lake in 1979 (U.S. Army Corps of Engineers, 1980).

Another area of concern is the effect of the Garrison Diversion Unit on fish and wildlife resources. The currently authorized plan is estimated to cost about $699.4 million and is intended to provide irrigation waters to 250,000 acres, potential water deliveries to a minimum of 14 communities, and nine recreation areas. The Devils Lake Chain would be restored and stabilized, with improved water quality. A total of 146,530 acres would be provided for wildlife management to mitigate habitat losses. Concern about the major biological impacts of the authorized plan for the Garrison Diversion Unit have been related to the following: the potential adverse

effect on 13 National Wildlife Refuges (Stump Lake NWR and Lake Alice NWR in the Devils Lake Basin); water quality degradation; large wetland losses; channelization of 107 miles of streams; and the introduction of fish diseases and exotic fishes from the Missouri River Basin into the James, Sheyenne, and Red rivers, with the result of degrading the fisheries in these streams, as well as adversly affecting Canadian commercial and sport fisheries in the Hudson Bay drainage (U.S. Fish and Wildlife Service, 1979).

The U.S. Fish and Wildlife Service has proposed a Recommended Plan for the Garrison Diversion Unit. The major differences between the Recommended Plan and the authorized Garrison Diversion Unit Plan are as follows:

1. The Recommended Plan would irrigate 96,300 acres of land compared to 250,000 acres for the authorized plan.
2. The Recommended Plan provides for 56,847 acres for wildlife management compared to 146,530 acres for the authorized plan. The authorized plan would need to provide 197,977 acres for wildlife if reevaluated using the criteria for acre-for-acre replacement of wetlands as was used for the Recommended Plan.
3. The Recommended Plan would substantially reduce wetland losses. Water quality impacts and the need for stream channelization would be eliminated from the Wild Rice and Souris Rivers. Potential impacts to Canada of the authorized plan would be significantly reduced by the Recommended Plan.
4. The Recommended Plan would require 103,187 acres of land made up of 42,776 acres for project features, 3,564 acres for recreation, and 56,847 acres for fish and wildlife. The authorized plan would require 213,701 acres of land made up of 62,656 acres for project features, 4,515 acres for recreation, and 146,530 acres for fish and wildlife. There are 61,431 acres of land left to acquire for the Recommended Plan as compared to 165,775 acres left to acquire for the authorized plan.
5. The Recommended Plan would cost about $399,070,000 compared to about $699,400,000 for the authorized plan. The remaining cost of the Recommended Plan is about $259,763,000 as compared to about $560,093,000 for the authorized plan.

Table 4 presents a comparison of fish and wildlife impacts associated with the U.S. Fish and Wildlife Service's recommended plan and the presently authorized plan. Reauthorization would be required before the recommended plan could be implemented.

Table 4

COMPARATIVE ANALYSIS OF THE IMPACTS OF THE RECOMMENDED AND AUTHORIZED PLANS FOR THE GARRISON DIVERSION UNIT ON FISH AND WILDLIFE HABITAT

| | Recommended Plan | Authorized Plan |
|---|---|---|
| Wetlands[1] (Acres) | | |
| Before | 21,796 | 79,767 |
| After | 25,468 | 73,682 |
| Grasslands[1] (Acres) | | |
| Before | 23,694 | 67,728 |
| After | 60,908 | 113,911 |
| Trees (Acres) | | |
| Lost | 1,352 | 4,046 |
| Planted | 1,000 | 1,200 |
| Total Project Lands (Acquisition Acres) | 103,187 | 213,701 |
| Total Fish and Wildlife Development (Acres) | 56,847 | 146,530 |
| Channelization (Miles) | 3 | 107 |
| Refuges Potentially Affected | | |
| Audubon NWR | X | X |
| Arrowwood NWR | X | X |
| Tewaukon NWR | | X |
| J.C. Salyer NWR | | X |
| Sand Lake NWR | X | X |
| Lake Alice NWR | | X |
| Upper Souris NWR | | X |
| Des Lacs NWR | | X |
| Sheyenne Lake NWR | X | X |
| Dakota Lake NWR | X | X |
| Wild Rice NWR | | X |
| Stump Lake NWR | | X |
| Potential Inter-Basin Transfer of Biota | | |
| Sheyenne Basin | X | X |
| Souris Basin | | X |
| Wild Rice Basin | | X |
| Red River of the North Basin | X | X |
| Potential Rough Fish Introduction | | |
| Souris River | | X |
| Upper Sheyenne | X | X |
| Devils Lake Basin | | X |

[1]Does not include wetland and grassland acres impacted on NWR's.

Source: U.S. Fish and Wildlife Service (1979).

## Recreation Problems

Although recreation resources are among the most abundant in eastern North Dakota, recreation sites are generally confined to the southern portion of the subbasin. There is little stream fishery, and while lake fishery is considered excellent in Devils Lake, declining water quality in other lakes in the subbasin may eventually have detrimental affects on the area's fishery resources. In addition, the salinity level of Devils Lake has been increasing in past years, which also diminishes water quality. Agricultural run-off and wind erosion, which contribute excessive nutrients to subbasin waters, also diminish water quality in the area.

## Water Quality Problems

The water quality problems of the subbasin are basically naturally occurring. Since Devils Lake is the last body of water in a closed basin, the chemical constituents such as TDS levels are concentrated due to evaporation. Nitrogen and phosphorous concentrations frequently exceed the acceptable limits. These, too, occur naturally in the soil and in plant material. However, the major contributors of nitrates and phosphates are feedlot runoff and agricultural erosion. Municipal and industrial discharges and wastes from waterfowl further degrade the subbasin's surface water quality. Wastewater treatment will be discussed in a later section. During the spring runoff, the water quality of Devils Lake seems to improve simply because the concentrations of the pollutants are diluted. Actually, the spring floods flush more pollutants into the lake, which are left in greater concentrations during the summer months when there is a high evaporation rate. Mauvais Coulee, the lake's major tributary, has naturally occurring problems with high sulfate levels (Upper Mississippi River Basin Commission, 1977; North Dakota Statewide 208 Water Quality Management Plan, 1978; Devils Lake Basin Advisory Committee, 1976).

The aquifers in the subbasin generally contain waters of an adequate quality. Moderate iron and manganese concentrations occur frequently, but these can be corrected by treatment. Some of the municipal supplies, however, contain TDS levels that exceed the desirable limits of 1000 mg/l. High sulfate and nitrate concentrations also present problems in a few supplies (Souris-Red-Rainy River Basins Commission, 1972).

## Water Supply Problems

Water supply problems in the subbasin are few and center around the quality of the groundwater. Much of the supply from the Dakota sandstone aquifer is not potable due to high proportions of sodium, chlorides and dissolved solids. Some of the smaller communities such as Edmore and Minnewaukan have supplies which are high in dissolved solids. The yields from present sources are indicated to be adequate in meeting the municipal water requirements for the major towns in the subbasin.

## Erosion Problems

Sheet and wind erosion are problems within the subbasin. Sheet erosion occurs mainly on the steeper slopes, sometimes depositing sediment on cultivated cropland. Wind erosion can harm fields lacking land cover or other types of protective measures. Wind deposited sediment in channels is a problem; deposits restrict the free flow of water and aggravate the flood problem. This accumulation necessitates the expenditure of funds for cleanout purposes and demonstrates the need for land treatment measures to prevent erosion.

## Irrigation

The irrigation of agricultural land is increasing in North Dakota because many farmers have found that supplemental irrigation is necessary to improve the yield and quality of their crops. Most of the irrigation, however, takes place along the Missouri River, which is west of the Red River Basin.

Two of the counties (Eddy and Benson) within the subbasin have about 80,000 acres of potentially irrigable land, but adequate water supplies are not available. The central and northern parts of the subbasin (Rolette, Ramsey, Cavalier, and Towner counties) are not being irrigated because the ground water surveys have not been completed. If irrigation is to be used on a large scale in this subbasin, ground water surveys will have to be completed, and an adequate water supply will have to be available.

## Wastewater Management

As was discussed earlier, the major pollution problems of the subbasin, other than natural features, are the non-point sources such as livestock and agricultural runoff. Still, municipal point sources do contribute

to the degradation of the subbasin's water quality. Table 5 presents the treatment facilities and needs of 17 communities within the subbasin. As indicated by the data, several communities are operating near or exceeding the designed capacities of their treatment facilities. The discharges of these point sources help to create excessive TDS, nitrate, and phosphate concentrations in the subbasin's numerous water bodies (Upper Mississippi River Basin Commission, 1977; Shewman and North Dakota State Department of Health, no date).

Hydropower

There is an existing dam on Lake Alice in Ramsey County within the subbasin. This site has been identified by the U.S. Army Corps of Engineers' Institute for Water Resources as a small scale facility with a potential for hydroelectric development, but it does not appear to be economically feasible.

Public Perception of Problems and Solutions

The public's perception of problems and solutions in the subbasin is partially defined through the activity of the Devils Lake Advisory Committee. This committee was formed in 1976 through a legislative act. Portions of the watershed are organized as a watershed district, but the Devils Lake Basin Advisory Committee is authorized to provide a plan for the basin through the coordination of Federal, state and local agencies.

Since the early 1970's, citizen commentary on water problems in the subbasin has been continuous. In 1972, citizens formed a group called Citizens for Preservation. This coalition petitioned for lowering of the water level of Devils Lake. In the same year, the Starkweather Watershed Project stated its goal for aquisition of wetland mitigation acres. During 1973, the state water commission met and heard citizen requests to delay formation of the Devils Lake Advisory Committee. It was felt that the formation of this committee might block construction of the Starkweather Watershed project. Water related problems continued in the subbasin, and in 1976 the legislature acted to create the Devils Lake Advisory Committee.

The Devils Lake Advisory Committee conducted public meetings beginning in the fall of 1975 in which some 19 specific suggestions were solicited and received from the general public regarding the role of the Committee.

Table 5

WASTE PRODUCTION INVENTORY
DEVILS LAKE SUBBASIN

| Community | Population Served | Design Flow (MGD) | Actual Flow (MGD) | Type Treatment | Surface Area (Total Acres) | Needs or Comments |
|---|---|---|---|---|---|---|
| Alsen | 201 | N/A | .013 | Primary | Septic Tanks | Lagoon Being Bid |
| Bisbee | 305 | .074 | .020 | Secondary | 10.0 | Construct New Cells |
| Cando | 1,512 | .154 | .098 | Secondary | 23.69 | Construct New Lagoon |
| Crary | 150 | .028 | .009 | Secondary | 4.24 | Completed Fall 1974 |
| Devils Lake | 7,078 | 1.47 | .460 | Secondary | 201.60 | -- |
| Edmore | 398 | .049 | .026 | Secondary | 6.6 | Construct New Lagoon |
| Egeland | 96 | N/A | .006 | Primary | Septic Tanks | Potential Lagoon |
| Fort Totten | 785 | .025 | .051 | Secondary | 3.73 | Construct New Lagoon |
| Hampden | 114 | .009 | .007 | Secondary | 1.60 | Reline Existing Cell |
| Lakota | 964 | .133 | .062 | Secondary | 18.0 | -- |
| Lawton | 123 | .019 | .008 | Secondary | 3.11 | -- |
| Leeds | 626 | .065 | .041 | Secondary | 10.0 | Construct New Lagoon |
| Minnewauken | 496 | .037 | .032 | Secondary | 5.0 | Construct New Cells |
| Munich | 249 | .022 | .016 | Secondary | 3.0 | Construct New Lagoon |
| Nekoma | 84 | .016 | .005 | Secondary | 2.53 | -- |
| Rolla | 1,458 | .129 | .095 | Secondary | 20.0 | -- |
| Starkweather | 193 | .018 | .013 | Secondary | 2.5 | Construct New Cells |

Source: Shewman and North Dakota State Department of Health, no date; North Dakota Statewide 208 Water Quality Management Plan, 1978.

Results of a survey conducted by the Advisory Committee show that residents perceive that the water damage that occurs almost every year is a result of insufficient culverts and drainage. It was also stated by residents that correction of the basin drainage problem is vital to the preservation of agricultural lands. A third of those surveyed felt that their flood problems were associated with upstream drainage and indicated a desire to drain 36 percent of the existing wetlands.

# IV. DESCRIPTION OF SUBBASIN RESOURCES

## IV. DESCRIPTION OF SUBBASIN RESOURCES

This section of the report discusses the primary resource conditions within the subbasin that are water-related and that would be affected by a comprehensive water and related land resources plan centering on flood control measures.

### Social Characteristics

This is a rural subbasin whose economic base for decades has been agriculture. For the past several decades, the farm population has steadily declined, and the urban population has grown slightly. The farm population has decreased due to mechanization and farm enlargement, which have reduced agricultural employment and caused many people to move to urban areas. Between 1960 and 1970, out-migration was so prevalent that the subbasin's total population decreased by about eight percent. During the 1970's, farm consolidation decreased, and agricultural employment stabilized. The result was an increase in subbasin population from 27,110 in 1970 to 28,046 in 1977, which was a 3.5 percent increase. The counties of Cavalier, Ramsey, and Walsh had natural increases (more births than deaths) and net in-migration rates of 5.4, 0.8, and 0.2 percent, respectively. Both Rolette County and Benson County experienced net out-migration (-0.9 and -2.6 percent, respectively), but their natural increases offset this, and the total population increased. Towner and Eddy counties had total population decreases due to out-migration (-6.7 percent and -9.5 percent, respectively). Nelson County's population increased solely because of in-migration (5.8 percent), which offset the natural decrease (more deaths than births) that occurred. The population density of the subbasin increased from 7.6 persons per square mile to 7.8 persons per square mile between 1970 and 1977.

The only urban center in the subbasin is the city of Devils Lake, which had a 1977 population of 7,468 that constituted a 5.5 percent increase over 1970. The town of Rolla (1,603) increased by 5.3 percent during the 1970's, and Lakota (1,125) increased by 16.7 percent. The town of Cando in Towner County decreased in population from 1,512 to 1,410, which was a 6.7 percent decrease. All of the other towns in the subbasin have populations of less than 700.

A significant portion of the subbasin residents are of Norwegian background, ranging from 36 percent in Walsh County to 50 percent in Benson. Approximately 45 percent of the Cavalier and Rolette county populations are of Canadian descent. The minority population is too small to be identified; however, there are two Indian Reservations within the subbasin. The Turtle Mountain Chippewa Reservation occupies 46,080 acres in the northern portion of the subbasin and has an estimated population of 8,160. The Fort Totten Reservation is the home of the Devils Lake Sioux and occupies a total of 244,000 acres. The total Indian population living on the reservation was estimated in 1978 as 2,815.

Communities are close knit, as can be seen by home ownership, length and county of residence, and county of employment. Most of the subbasin residents own their homes, ranging from 65.7 percent in Rolette County to 78.6 percent in Walsh County. From 52 percent of the 1970 population in Rolette County to 71 percent in Cavalier and Walsh counties occupied the same residence as in 1965. A high percentage of persons changing residences remained in the same county, ranging from 76 percent in Ramsey County to 91 percent in Cavalier County. Most of the population in the subbasin is employed in the county of residence, ranging from 83 percent in Cavalier County to 96.3 percent in Eddy County.

## Economic Characteristics

### Employment

Although farm employment has decreased during recent years, it is still the most important sector in the subbasin. Employment in the subbasin centers around agriculture, retail trade, services, and education. These four sectors are estimated to account for more than 70 percent of the subbasin's employment. Agriculture alone amounts to almost 30 percent of the subbasin's employment. While farm employment has decreased, other sectors have increased, and the subbasin has had an increase in total employment. Between 1970 and 1977, total employment increased from 9,489 to 12,340, which was an increase of 30 percent.

Unemployment in the subbasin averaged about 6.5 percent during the 1970's. Employment is high during the spring, summer, and fall, when agricultural crops are planted and harvested. During the winter, many agricultural activities decrease drastically.

## Income

Total personal income for the subbasin increased from $160 million to $203 million between 1969 and 1977 (as expressed in 1979 dollars). Farm income accounts for more than half of the total personal income, and cash grain sales amount to more than 70 percent of the total farm income. Average per capita income during the same years increased from $5,875 to $7,242, which was slightly above the 1979 average income figure of $6,859 for the whole state.

## Business and Industrial Activity

### Agriculture

Agriculture is the predominant sector in the subbasin's economy, and the production of small grains is the most important agricultural component. Approximately 78 percent (or 1,787,136 acres) of the subbasin's land area is under cultivation, and another 9.6 percent is devoted to pasture.

The major crops grown in the subbasin are identified in Table 6. Wheat is the leading crop, accounting for 54 percent of the harvested acreage. This is followed by barley, sunflowers, hay, oats, and flax, which collectively amount to 45 percent of the harvested acreage. There are also minor acreages of rye, potatoes, sugarbeets, and corn. The importance of sunflowers has increased dramatically during the 1970's. Between 1977 and 1978, sunflower production in North Dakota increased by more than 50 percent. In the subbasin, this crop became the third leading crop, accounting for eight percent of the total harvested acreage.

Table 6

1978 CROP STATISTICS, DEVILS LAKE SUBBASIN

| Crop | Harvested Acres | Yield Per Acre | Total Production |
|---|---|---|---|
| Wheat | 617,100 | 30.9 bushels | 19,068,390 |
| Barley | 284,450 | 42.5 bushels | 12,089,125 |
| Sunflowers | 94,470 | 1,313 pounds | 124,039,110 |
| Hay | 85,680 | 2.0 tons | 171,360 |

Source: Gulf South Research Institute.

The central portion of the subbasin has the most productive soils and is devoted to growing small grains, sunflowers, potatoes, soybeans, and sugarbeets. The north central part of the subbasin is an area with sandy soils in which the major crops grown are flax, small grains, and sunflowers. The south central part of the subbasin has poorly drained soils, which mainly grow flax, corn, small grains, and legumes. There is also some native grass rangeland. The rest of the subbasin contains rich soils that are used for growing small grains, sunflowers, potatoes, and corn.

Cropping patterns within the floodplain of the subbasin are similar to those throughout the subbasin. The major crops grown are small grains, sunflowers, potatoes, corn, soybeans, and sugarbeets.

### Manufacturing

There are 55 manufacturing establishments in the subbasin, 29 of which are located in the city of Devils Lake. More than 30 percent of the manufacturers are related directly to the agriculture industry. The remainder of the manufacturers are a diversified industrial mix and account for about six percent of the subbasin's manufacturing employment. The manufacturing establishments are grouped in Table 7 according to their Standard Industrial Code (SIC) numbers.

### Trade

In 1977, total trade receipts for the subbasin exceeded $240 million (expressed in 1979 dollars). Approximately 65 percent (or $156.6 million) of the receipts were wholesale trade. Retail trade and selected service receipts were $83.5 million and $7.9 million, respectively, in 1977.

### Transportation Network

The major north to south highways in the subbasin are State Highways 1 (through Lawton, Brocket, and Lakota) and 20 (through Munich and Devils Lake) and U.S. Highway 281 (through Rolla, Rock Lake, Cando, Maza, and Minnewaukan). Each of these highways intersects U.S. Highway 2, which is the major east to west artery and a direct route to the city of Grand Forks. Other state highways which cross the subbasin include 66, 17, and 19, and there are numerous county roads throughout the subbasin.

Table 7

MANUFACTURING ESTABLISHMENTS, DEVILS LAKE SUBBASIN

| SIC | Description | Estimated Employment |
|---|---|---|
| 14 | Mining of Nonmetallic Minerals | 27 |
| 17 | Construction-Special Trade Contractors | 18 |
| 20 | Food and Kindred Products | 80 |
| 24 | Lumber and Wood Products | 9 |
| 27 | Printing and Publishing | 95 |
| 29 | Petroleum Refining and Related Industries | 20 |
| 30 | Rubber and Plastics Products | 20 |
| 32 | Stone, Clay, Glass, and Concrete Products | 60 |
| 34 | Fabricated Metal Products | 9 |
| 37 | Transportation Equipment | 9 |
| 39 | Miscellaneous Manufacturing Industries | 150 |
| 42 | Motor Freight Transportation/Warehousing | 45 |
| 50 | Wholesale Trade-Durable Goods | 9 |
| 51 | Wholesale Trade-Nondurable Goods | 54 |
| 54 | Food Stores | 70 |
| 76 | Miscellaneous Repair Services | 18 |
| TOTAL | | 693 |

Source: 1977-1979 Directory of North Dakota Manufacturing.

The Burlington Northern Railroad has rail lines through the cities of Munich, Hampden, Cando, Churchs Ferry, Lawton, Brocket, Edmore, and Devils Lake. The Soo Line Railroad has rail lines through Calio, Munich, Alsen, Loma, and Devils Lake. There are municipal airports located at Cando, Devils Lake, Lakota, Larimore, Leeds, and Rolla. Most of these airports are very small and have limited facilities.

Land Use

Approximately 71 percent of the subbasin is under cultivation, 19.6 percent is pasture, 2.8 percent is urban, 1.2 percent is forest, and 3.1 percent is water.

Forested areas are found mainly in the south central portion of the subbasin along the shore of Devils Lake and in the Devils Lake Indian Reservation. Although most of the land is under cultivation, the richest soils are found in the central and northern parts of the subbasin. Pasture and rangeland is more common in the southern portion of the subbasin.

## Environmental Characteristics

### Climate

Climatological information is available at Rolla and Devils Lake. The climate of the subbasin is subject to wide seasonal variations. Records at Devils Lake weather station show mean monthly temperatures varying from 68°F in the summer to 3.7°F in the winter. The long hours of summer sunshine make it possible to grow and mature many differnent crops even though the growing season averages only 131 days. The average annual precipitation is 16.98 inches. Mean annual snowfall at Devils Lake is 36 inches, which is equivalent to approximately three inches of moisture. Snowmelt runoff causes damaging floods from March through May. Excessive rainfall from May through September also causes overflow of low capacity channels, resulting in serious damage to maturing crops.

### Geology

The subbasin lies within the Western Lake Section of the Central Lowlands Province in the Interior Plains Division. Bedrock consists of a small section of the Fox Hills Sandstone formation in the northwestern corner of the subbasin and the light to medium gray shale of the Pierre Shale formation. The Fox Hill Sandstone extends to a depth of 350 feet, and the Pierre Shale varies form 150 to 860 feet in thickness. The Pierre Shale is an important aquifer in the subbasin. Glacial drift, ranging from a few feet to 300 feet in thickness, overlies bedrock. Glacial till, composed of a heterogeneous mixture of clay, silt, sand, and gravel, is overlain by glacial lake deposits from Lake Cando and Devils Lake in the central and southern portions of the subbasin. Alluvial deposits along the floodplains of major streams are also present. Numerous lakes and depressions are characteristic glacial features found in the subbasin.

Biology

Stewart (1975) indicated that the woodlands in the subbasin are characterized by the Northeastern Upland Deciduous Forest. Best representation is found in the Pembina River Subbasin, but similar communities with a more limited fauna and flora occur in the hills near the south shore of Devils Lake. Dominant trees include a mixture of deciduous species such as quaking aspen, balsam poplar, paper birch, bur oak, American elm, boxelder, basswood, and green ash. The midstory strata is composed of small trees and shrubs like American and Beaked hazelnut, black currant, Missouri gooseberry, hawthorn, chokecherry, smooth sumac, downy arrowwood, and highbush cranberry. Common species in the herbaceous layer include rattlesnake fern, virginia wildrye, false Solomon's seal, carrion flower, smooth blue aster, yellow wood parsnip, and common blue violet.

Kuchler (1964) illustrated the potential natural vegetation of North Dakota in which he showed the Oak-Savanna (Quercus-Andropogon) and Wheatgrass-Bluestem-Needlegrass (Agropyron-Andropogon-Stipa) communities as the major vegetation types in the Devils Lake Subbasin. The Oak-Savanna type occurs primarily in three areas: (1) a continuous area along the meandering Ramsey-Benson County line in the southern part of the subbasin through the Devils Lake area, (2) a smaller area in the upper reaches of Mauvais Coulee in the region of the Benson-Ramsey-Towner County intersection, and (3) a small area in the Chain Lakes region between Dry Lake on the west and the Edmore Coulee area on the east. The U.S. Army Corps of Engineers (1977) has described this community as the Upland Oak Savanna Woodland, which occurs on dry south- and west-facing slopes and occasionally on upland areas. Dominant trees include bur oak, some aspen, boxelder, and ash. Principal shrub species consist of small wolfberry, saskatoon and chokecherry. Typical herbaceous flora are columbine, canada anemone, and Pennsylvania sedge.

The Wheatgress-Bluestem-Needlegrass community, described by Stewart (1975) as the Eastern Mixed-grass Prairie, is composed of a mixture of mid and short grasses and forbs. Common species include little bluestem, green needlegrass, wheatgrass, needle-and-thread, blue gramma, prairie junegrass, and yellow sedge. Kentucky bluegrass, an

invading exotic, may be prevalent in areas. Small areas of low shrubs, composed principally of wolfberry, are frequently common in draws and on east- and north-facing slopes.

Wetlands of the subbasin include Devils Lake, Stump Lake, the Sweetwater chain of lakes, and the numerous potholes and marshes remaining in other areas of the region. Wetland types which are known to occur in the counties included by the subbasin include: Type 1--seasonally flooded basins and flats; Type 3-- shallow fresh marshes; Type 4--deep fresh marshes; Type 5--open fresh water; Type 10--inland saline marshes; and Type 11--inland open saline waters (Soil Conservation Service, 1969; U.S. Fish and Wildlife Service, 1979).

Habitats of importance to wildlife in the subbasin include the extensive woodlands and the remaining wetlands and grasslands. The woodlands and brushy areas provide excellent den and nesting sites, territories, winter and escape cover, and winter food for many of the resident and migratory wildlife species in the region. They also furnish a travel corridor for animals moving from the agriculturally developed regions of the subbasin. Because of the large woodland areas of the sunbasin, deer populations are very good, as are the densities of other forest-oriented animals. Forests afford breeding and nesting areas for birds and rank second only to wetlands in breeding bird population densities, with 336.0 pairs/$km^2$. Forests contain a greater variety of wildlife species than any other major habitat type; thus, there is a very real need to protect the extensive woodlands of the subbasin. Wetlands furnish breeding, nesting, feeding, and resting areas for waterfowl; breeding and rearing habitat for big and small game, furbearers, and other wildlife such as passerine and wading birds; spawning and nursery areas for fishes and aquatic invertebrates; and a high-yield food source for many resident species. As indicated above, they rank first in breeding bird densities, with average populations reported at 337.0 pairs/$km^2$. The subbasin is one of the most important waterfowl production areas in the state and serves as a major staging area for ducks and geese migrating down the Central Mississippi and Atlantic flyways. Native grasslands or prairie, when found in combination with wetland complexes, form a dynamic and varied ecosystem which supports diverse

and abundant populations of birds, mammals, invertebrates, and plants. Average breeding bird densities of 142.7 pairs/$km^2$ have been recorded in this highly productive community. Like the woodlands, both the remaining wetlands and prairies of the subbasin need to be protected, conserved, and enhanced wherever possible (U.S. Fish and Wildlife Service 1979, 1980; U.S. Army Corps of Engineers, 1980; Soil Conservation Service, 1969; Souris-Red-Rainy River Basins Commission, 1972).

The single important big game animal of the subbasin is the white-tailed deer, which has population densities varying from low (<0.5 deer/square mile) to high (>1.5 deer/square mile). The greatest abundance occurs in the heavily wooded sections around Devils Lake southeast to the edge of the subbasin's limits at the Nelson-Benson-Ramsey County junction. Moderate densities (0.5-1.5 deer/square mile) occur west of Devils Lake through Benson County, while low populations are encountered north of Devils Lake into Ramsey, Cavalier, and Towner counties. As indicated in the preceding paragraph, waterfowl production is high (>9.0 breeding pairs/square mile) throughout nearly all portions of the subbasin. Moderate spring breeding densities (4.0-9.0 breeding pairs/square mile) are found in the northeastern section in the Cavalier-Ramsey-Walsh County junction area. The most important breeding species are the mallard, blue-winged teal, pintail, gadwall, northern shoveler, and green-winged teal. The subbasin is also noted for its excellent fall goose hunting, when 120,000 to 200,000 geese (mainly Canadas, blues, and snows) are found for extended periods on their southward migration. During the spring, 200,000 to 500,000 birds migrate back through the subbasin on their way to northern breeding grounds. Small game animals include the eastern cottontail and tree squirrels (data from North Dakota Game and Fish Department in U.S. Fish and Wildlife Service, 1970; Souris-Red-Rainy River Basins Commissions, 1972).

The Hungarian partridge is the primary upland game bird, with population densities considered high (32-60 birds/1,000 miles of rural mail carrier route) throughout most of the subbasin, except in the northern part above Cando where densities are moderate (12-31 birds/1,000 miles). Pheasants

and sharp-tailed grouse are also hunted, with moderate pheasant populations (1.0-10.0 hens/square mile) in the southern half and low densities (<1.0 hen/square mile) in the northern half. Sharp-tailed grouse densities are low (<3.0 sharptails/square mile) east and north of Devils Lake and moderate (3.0-6.0 sharptails/square mile) in the remaining portion. Common furbearers include the red fox, beaver, mink, muskrat, and skunk. Red fox densities are moderately high throughout the subbasin, with 9.0-13.0 families/township (data from North Dakota Game and Fish Department in U.S. Fish and Wildlife Service, 1979). Table 8 gives harvest data for many of the game and furbearing species mentioned above in Walsh, Nelson, and Eddy counties.

A total of nine amphibian and seven reptile species have been reported from the northeastern region of North Dakota, which includes Nelson and Walsh counties on the eastern side of the Devils Lake Subbasin. These numbers and species generally agree with those indicated for the Sheyenne River Subbasin, which includes Nelson, Eddy, Benson, and Pierce counties on the south and western sides of the Devils Lake Subbasin. Common species include the tiger salamander, chorus frog, snapping turtle, and plains garter snake (Willis, 1977; Wiehe and Cassel, 1977). About 137 species of birds breed in the Devils Lake Subbasin and are comprised of 10 species of game birds, 114 species of nongame birds, and 13 species of waterfowl. Typical species and their primary breeding habitats include the horned lark in grasslands-agricultural fields, great horned owl in forests, and the red winged blackbird in wetlands. A total of 40 species of mammals occur in the subbasin: one species of big game, three species of small game, 13 species of furbearers, and 23 nongame species. Fairly common to common nongame mammals are the masked shrew, big brown bat, and thirteen-lined ground squirrel in grasslands; red bat and white-footed mouse in forests; and the short-tailed shrew in wetlands. Fourteen species of mammals are known to have been extirpated within the subbasin (Devils Lake Basin Advisory Committee, 1976).

This subbasin is unique in that Devils Lake has no natural drainage since the subbasin is completely surrounded by hills of higher elevation than the lake. The main tributary of Devils Lake is Big Coulee,

Table 8

1975 HARVEST DATA FOR GAME AND FURBEARING ANIMALS IN THREE COUNTIES INCLUDED BY THE DEVILS LAKE SUBBASIN

| Species | Number Harvested | | | |
|---|---|---|---|---|
| | State Harvest | Walsh County | Nelson County | Eddy County |
| Redfox (trapped[a] and hunted) | 41,514 | 117 | 775 | 457 |
| Coyote (trapped[a] and hunted) | 2,060 | 0 | 7 | 5 |
| Sharp-tailed grouse | 159,000 | 670 | 270 | 619 |
| Ring-tailed pheasant | 66,116 | 0 | 0 | 0 |
| Cottontail | 53,487 | 2,105 | 1,284 | 1,926 |
| White-tailed deer | 24,627 | 147 | 293 | 239 |
| Hungarian partridge | 127,500 | 3,175 | 2,805 | 791 |
| Tree squirrel | 26,404 | 3,812 | 815 | 0 |

[a]Represents 1975-76 harvest figures.

Source: North Dakota Game and Fish Department in U.S. Fish and Wildlife Service (1979); Wiehe (1978).

which originates from Lake Irvine and Lac Aux Mortes. Mauvais Coulee is the main tributary of these two lakes. The water quality of these coulees has been degraded by agricultural runoff and channelization (U.S. Fish and Wildlife Service and North Dakota Game and Fish Department, 1978). The water quality of Devils Lake is degraded by the runoff from these tributaries, and this problem is compounded by increased dissolved solids due to evaporation (U.S. Army Corps of Engineers, 1980).

A small branch of the Mauvais Coulee has been classified by the U.S. Fish and Wildlife Service and North Dakota Game and Fish Department (1978) as a Class III stream. The justification of this evaluation is that this short reach provides a moderate forage fish production, receives moderate waterfowl production, and supplies water to Devils Lake. The main stem of Mauvais Coulee and Big Coulee have both been designated as streams with very high fishery resources (Class I). Both receive heavy waterfowl use, provide a moderate forage fish production, and provide a high reproduction of northern pike. They are both critical to the maintenance of Devils Lake water quality and quantity.

Devils Lake's fishery resource depends largely upon the spring runoff. These waters help to dilute the water in Devils Lake, which is normally high in dissolved solids. The North Dakota Game and Fish Department has recently stocked the lake with several species of sport fishes. Perch, bass, and crappie are among the stocked species which appear to have established breeding populations. Walleye, on the other hand, have not had such a successful survival record. The Game and Fish Department reported that approximately 400,000 pounds of sport fishes were harvested from Devils Lake in 1979 (U.S. Army Corps of Engineers, 1980).

Water Supply

Nine communities in the subbasin have municipal water supplies, and all rely on groundwater. A number of major glacial drift aquifers are known or suspected to exist in the subbasin. A plentiful supply of water can be obtained from the Dakota sandstone at a depth of about 1,000 feet, however, the water from the Dakota sandstone is not potable due to high proportions of sodium, chlorides, and dissolved solids. The North Dakota

State Department of Health reports that the major towns of Devils Lake and Rolla use approximately 438,000,000 gallons and 52,925,000 gallons, respectively, annually. The cities of Cando and Lakota each use about 54,750,000 gallons per year. Aside from some moderate iron and manganese problems that can be corrected by treatment, the mineral quality of these supplies is quite good.

Water Quality

Table 9 presents the surface water quality data of four major lakes in the subbasin and Mauvais Coulee. The data presented in the table indicate that these bodies of water generally contain excessive levels of hardness, TDS, sulfates, and pH. Metals such as barium, boron, and lithium also present problems at times. Runoff from agricultural operations is the major contributor of the metals and TDS concentrations. High levels of nitrates and phosphates, although naturally occurring, also result from livestock and cropland erosion. Low flows in Mauvais Coulee also degrade the water quality by decreasing the dissolved oxygen concentrations and increasing the TDS levels. Since there is no natural outlet for Devils Lake, the pollutants that are brought into the lake from other tributaries are further concentrated by evaporation (U.S. Geological Survey, 1979; Upper Mississippi River Basin Commission, 1977; Devils Lake Basin Advisory Committee, 1976).

The groundwater supplies of the subbasin are generally considered to be good. Some, however, are characterized by excessive levels of nitrates and sulfates. TDS concentrations exceed the desirable limits of 1,000 mg/l in a few supplies. Some supplies contain moderate amounts of iron and manganese, but these problems can be solved with treatment (Souris-Red-Rainy River Basins Commission, 1972). Table 10 presents the groundwater quality of eight communities within the subbasin.

Aesthetics

Large portions of the subbasin have been cleared for agricultural purposes; however, heavily wooded areas remain, particularly in the rolling hills of the southern portion of the region. There are 14 wildlife management areas, including Sully's Hill National Wildlife Refuge, which is noted for elk, buffalo, deer, and waterfowl populations that may be viewed in their natural habitat.

Table 9

SURFACE WATER QUALITY WITHIN THE DEVILS LAKE SUBBASIN FROM OCTOBER 1977 TO SEPTEMBER 1978

| Parameter | Sweetwater Lake | | Lake Alice | | Lake Irvine | | Devils Lake | | Narrows of Devils Lake | | Mission Bay of Devils Lake | | Mauvais Coulee* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | Minimum | Maximum | Minimum | Maximum | Minimum | Maximum | Minimum | Maximum | Minimum | Maximum | Minimum | Maximum |
| pH (Standard Units) | 7.8 | 9.3 | 7.7 | 8.8 | 8.5 | 8.9 | 8.6 | 9.3 | 8.4 | 9.3 | 8.6 | 9.2 | 7.6 | 8.3 |
| Temperature ($^{o}$C) | 0.0 | 23.5 | 0.5 | 18.0 | 3.0 | 18.0 | 0.0 | 22.0 | 0.0 | 22.0 | 0.0 | 22.5 | 2.0 | 7.0 |
| Hardness ($CaCO_3$) | 220 | 420 | 220 | 680 | 250 | 570 | 800 | 970 | 830 | 1,000 | 960 | 1,300 | 150 | 500 |
| Sodium (Percent) | 35 | 40 | 22 | 34 | 27 | 35 | 59 | 62 | 58 | 60 | 63 | 65 | 18 | 30 |
| Sulfate | 160 | 360 | 110 | 600 | 150 | 490 | 1,400 | 1,700 | 1,400 | 1,700 | 1,900 | 2,700 | 87 | 390 |
| Chloride | 23 | 44 | 13 | 73 | 18 | 61 | 290 | 330 | 300 | 340 | 430 | 510 | 4.1 | 46 |
| Fluoride | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.4 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.1 | 0.1 | 0.2 |
| Total Dissolved Solids (TDS) | 463 | 908 | 355 | 1,340 | 426 | 1,160 | 2,950 | 3,500 | 2,970 | 3,490 | 3,900 | 5,290 | 237 | 852 |
| Nitrates (N) | 0.00 | 0.15 | 0.7 | 0.27 | 0.08 | 0.72 | 0.02 | 0.33 | 0.01 | 0.37 | 0.00 | 0.09 | -- | -- |
| Phosphorus (P) | 0.02 | 0.24 | 0.00 | 0.60 | 0.07 | 0.36 | 0.30 | 0.52 | 0.33 | 0.47 | 0.16 | 0.23 | -- | -- |
| Barium (mg/l) | 0 | 300 | 100 | 100 | 0 | 200 | 0 | 200 | 0 | 100 | 0 | 100 | -- | -- |
| Boron (mg/l) | 110 | 200 | 90 | 320 | 90 | 250 | 640 | 720 | 650 | 740 | 800 | 980 | 140 | 150 |
| Iron (mg/l) | 10 | 40 | 10 | 60 | 20 | 210 | 20 | 40 | 20 | 30 | 20 | 30 | 100 | 140 |
| Lithium (mg/l) | 50 | 100 | 30 | 150 | 40 | 120 | 270 | 340 | 280 | 350 | 350 | 470 | -- | -- |

Note: Unless otherwise stated, all units of measure are in milligrams per liter (mg/l).

*Only two samples were collected (October, 1977 and April, 1978).

Source: U.S. Geological Survey, 1979.

Table 10

GROUND WATER QUALITY FROM EIGHT CCMMUNITIES
WITHIN THE DEVILS LAKE SUBBASIN

| Parameter | Cando* | Devils Lake* | Edmore | Fort Totten | Lakota* | Leeds | Minnewauken* | Rolla |
|---|---|---|---|---|---|---|---|---|
| Total Dissolved Solids (TDS) | 849 | 446 | 1,177 | 394 | 1,352 | 3,710 | 1,050 | 1,354 |
| Hardness ($CaCO_3$) | 700 | 240 | 290 | 265 | 845 | 100 | 13 | 885 |
| Iron | 6.6 | 0.3 | Trace | 0.0 | 2.8 | 0.0 | 0.0 | 0.0 |
| Manganese | 0.5 | 0.3 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.2 |
| pH | 7.5 | 7.2 | 8.3 | 8.3 | 8.2 | 7.5 | 8.2 | 7.6 |
| Fluoride | 0.2 | 0.3 | 0.0 | 0.2 | 0.1 | 1.2 | 0.6 | 0.0 |
| Chloride | 30 | 3 | 2 | 10 | 56 | 1,050 | 45 | 40 |
| Sulfates | 210 | 38 | 253 | 155 | 750 | 1,163 | 230 | 505 |
| Nitrates | Trace | 0 | 0 | 0 | 0 | 444 | 11 | 22 |

*Parameters listed are from only one of two or more sources.

Note: All measures are made in mg/l (milligrams per liter).

Source: North Dakota State Department of Health, 1964.

The wooded shoreline of Devils Lake and the Fort Totten Indian Reservation also provide areas of aesthetic quality in the subbasin. Devils Heart, Devils Tooth, Devils Backbone, and Devils Table are natural landscapes named through Indian folklore and legend that create areas of aesthetic appeal and contribute to the topographical diversity of the subbasin.

Cultural Elements

In comparison to other parts of the Red River Basin, the archeology of the Devils Lake area has been investigated relatively well by amateurs, if not by professionals. Mounds of the Woodland culture period have attracted prolonged archeological attention over the past 100 years. During the 1880's, for instance, Henry Montgomery excavated 40 mounds in eastern North Dakota, including many in the Devils Lake area. He attempted to identify mound types, but made no effort to associate these remains with historic tribes (Pauxar 1957:14-15). Subsequent systematic surveys in the study area were made by Pauxar (1947) and Schneider et al., 1977, who also attempted a comprehensive inventory of historic sites in the subbasin. The Devils Lake Basin Advisory Commission (1976) also compiled an inventory of known archeological-historical sites for planning purposes.

The subbasin topography consists of extensive glacial till interspersed with lake-filled glacial valleys and glacial moraines. The numerous potholes and small lakes of the subbasin receive and retain surface runoff for extended periods of time. The importance of these topographic features to waterfowl production undoubtedly had significant effects upon the utilization of the subbasin by prehistoric and historic inhabitants.

Devils Lake and Stump Lake have been the major focus of archeological field surveys in the subbasin; and indeed, a substantial number of prehistoric and some historic sites were recorded here by Schneider et al., 1977. Water fluctuations in these lakes have been a constant, but changing response to various climatic factors during historic, as well as prehistoric, times. Abandoned shorelines, lake sediments, and tree lines illustrate fluctuating climatic conditions in the Devils-Stump lakes vicinity (Wedel 1961:16; Pauxar 1947:5). The possible correlations of these environmental responses to prehistoric cultural adaptations in the subbasin could help to illustrate further the archeological chronology of the northern plains.

Devils Lake figures prominently in the oral traditions of several North Dakota Indian tribes in much the same way that Mille Lac does for the Sioux. The Hidsatsa and Crow trace their migration route from the Devils Lake area to the Missouri and Heart rivers. Moreover, the Arapaho-Atsina reportedly migrated from the Sheyenne River area westward through the Devils Lake region to the Little Missouri River (Hewes, 1948:51-52). Further archeological investigations in the subbasin might help to clarify the archeological chronology of the region and to correlate archeological remains with ethnohistorical data.

The Sisseton and Wahpeton Sioux Indians controlled much of the subbasin during its most intensive period of white contact. In 1867, a reservation for these tribes, as well as for the Santee, Yanktonai, and Cut Heads, was established at Devils Lake. Its affairs were administered by officials at Fort Totten, which was built in that same year (Pauxar, 1947:12; Robinson, 1966:105). Indians of this region were reduced to reservation status due to the extermination of the buffalo by Metis hunters who lived just south of Devils Lake (Robinson, 1966:105). The area west of Devils Lake was hotly contested by both the Turtle Mountain band of Chippewas and by white settlers. In 1882, the area was officially opened to the public domain over the protests of the Chippewa. In that same year, a Chippewa reservation was established in Rolette County in the northwest corner of the subbasin (Robinson, 1966:147). The towns grew swiftly; in 18 months, the town of Devils Lake alone mushroomed to a population of 1,000 (Robinson, 1966:145). Many of the settlers in the subbasin were of Canadian and Norwegian heritage. Most of these Euro-Americans migrated directly from Minnesota, Wisconsin, and Iowa to establish new homesteads on the North Dakota frontier. There are four sites in the subbasin currently listed on the National Register of Historic Places. Other potentially significant cultural resources are likely to be identified in the future.

## Recreational Resources

Water-based and water-related recreation resources in the subbasin are among the most abundant in the North Dakota portion of the Red River Basin. There are approximately 20,189 acres of recreational lands in the subbasin. Most of the recreation sites are concentrated around the

major lakes, including Devils Lake, in the southern portion of the area, as illustrated in Figure III. A detailed inventory of facilities in areas larger than 15 acres, accounting for 99 percent of the total subbasin resources, is included in Appendix B of this report.

Hunting is a popular recreational activity in the subbasin. There are approximately 17,482 acres of wildlife management areas in the area, including nine National Wildlife Refuges, as well as waterfowl production areas which are open to public hunting. Upland game is limited because of lack of habitat, but the wetlands and Devils Lake provide excellent habitat for migratory waterfowl, including significant populations of duck and geese.

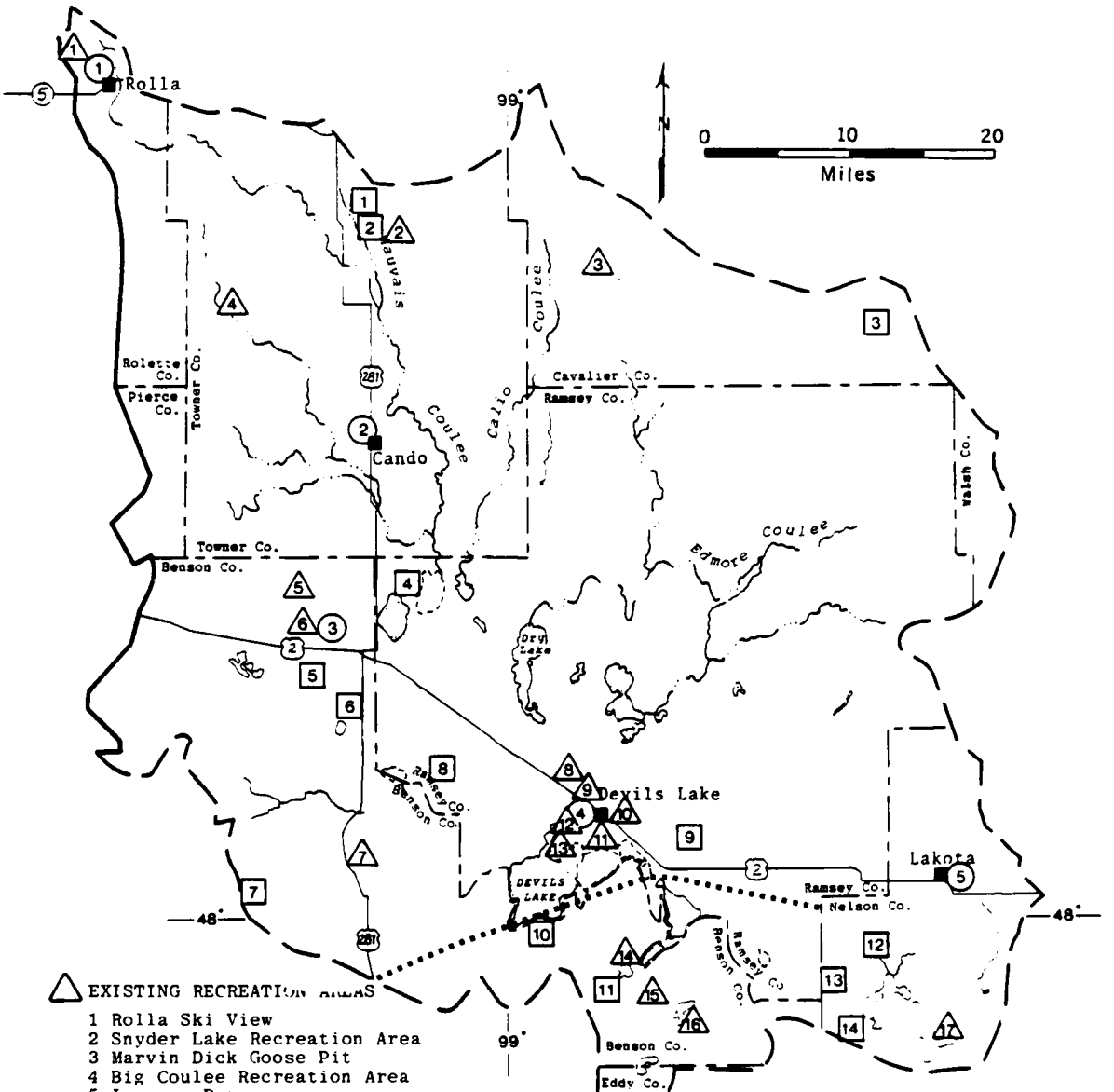
Devils Lake provides significant recreational opportunities, including boating, water-skiing, picnicking, and camping. Fishing is particularly productive in the lake, and a large percentage of the state pike harvest (48.3 percent in 1974-75) is taken from Devils Lake. The lake area has attracted private recreational development and has also fulfilled water-based recreational needs for residents of adjacent subbasins where resources are insufficient to meet demands.

A small portion of the proposed North Country National Scenic Trail would cross the southern portion of the subbasin near Devils Lake.

## Significant Environmental Elements

### Social

There are 25 towns in the subbasin ranging in population from 13 to 7,468 and accounting for 55 percent of the total population. The major population centers include Devils Lake, Rolla, Cando, and Lakota. Areas of flooding occur in the towns of Devils Lake, Starkweather, and Larimore, but most extensively in agricultural areas of the subbasin. Flooding problems in the towns include damages to residential and commercial establishments, roads and bridges, and municipal sewage treatment facilities. Potential health hazards in regard to municipal water supply and sewage collection and treatment as a result of flooding are social problems of environmental concern. Agricultural lands occupy 91 percent of the subbasin and provide direct and indirect employment for the majority




△ EXISTING RECREATION AREAS

1 Rolla Ski View
2 Snyder Lake Recreation Area
3 Marvin Dick Goose Pit
4 Big Coulee Recreation Area
5 Iverson Dam
6 Leeds Park and Pool
7 Minnewaukan Park
8 Highway 2 Campground
9 Ruger's Park
10 Roosevelt Park
11 Tumbleweed KOA
12 Zieback Recreation and Campground
13 Lakewood Park
14 Wood Lake Area
15 Sand Lake Area
16 Reeves Lake (Elbow Lake) Area
17 Old Settler's Park

○ OTHER EXISTING RECREATION AREAS

1 Rolla Country Club
2 Cando Golf Course
3 Leeds Golf Course
4 Devil's Lake Country Club
5 Lakota Golf Course and Range

□ EXISTING WILDLIFE AREAS

1 Brumba National Wildlife Refuge
2 Snyder Lake National Wildlife Refuge
3 Billings Lake National Wildlife Refuge
4 Lac Aux Mortes National Wildlife Refuge
5 Nesvig WMA
6 Silver Lake National Wildlife Refuge
7 Pelican Township WMA
8 Minnewaukan WMA
9 Crary
10 Sully's Hill National Wildlife Refuge
11 Wood Lake National Wildlife Refuge
12 Rose Lake National Wildlife Refuge
13 Black Swan WMA
14 Stump Lake National Wildlife Refuge

•••••PROPOSED RECREATION SITES

North Country National Scenic Trail

Source: Gulf South Research Institute.

Figure III. RECREATIONAL RESOURCES

of the subbasin's population. Flooding problems affecting significant portions of agricultural lands result in damages to topsoil, farm structures and equipment, and crops. Delay in planting and damages to mature crops result in reduced yields and proportional economic losses. The towns in the subbasin are primarily agricultural service centers and suffer indirect economic losses related to reduced incomes in the agricultural sector.

### Cultural

The Devils Lake Subbasin, like the Sheyenne River Subbasin, is relatively well investigated in terms of its cultural resources. The region figures prominently in the oral traditions of several Indian tribes and offers an opportunity to correlate archeological remains with ethnohistorical accounts. There are four sites listed on the National Register of Historic Places. Other potentially significant cultural resources are likely to be identified in the future.

### Soils

Soils of the subbasin are formed in materials weathered from glacial till, glacial outwash, and glacial sediments. Soils derived from the glacial drift vary from well-drained loams in the uplands to poorly drained clay loams that occur in the numerous shallow depressions. The heavier soils are frequently flooded. Principal soils formed in glacial till are Barnes, Buse, Hamerly, Svea, and Tonka. The principal soils formed in outwash and lake sediments are Bearden, Embden, Glyndon, Overly, and Ulen.

### Water

Slightly more than three percent of the total land area of the subbasin is covered by water. The largest body of water is Devils Lake, and there are numerous small lakes scattered throughout the subbasin. Due to the abundance of water areas, the subbasin provides significant recreational opportunities and wildlife habitats.

### Woodlands

The woodlands and brushy areas of the subbasin are considered significant because of their value as wildlife habitats, and, as explained in the

Problems and Needs section, compose one of the most important areas of natural woodlands remaining in the State of North Dakota. In addition to their value as habitats for wildlife, they are important for wildlife-oriented outdoor recreation and for their aesthetic appeal. It was further recognized under Problems and Needs that, during the period 1958-1967, clearing of private lands ranged from 0.1 to 3.6 percent annually in Cavalier, Towner, and Rolette counties. There is a very real need to protect these habitats and to enhance the forests in the upper portion of the subbasin where agricultural development predominates.

Wetlands

The wetlands of the subbasin are important because of their many functional uses and values such as waterfowl production areas, habitats for flora and fauna, water storage capacity during spring runoff and periods of extreme precipitation, groundwater recharge, and sediment and nutrient traps (Cernohous, 1979; U.S. Fish and Wildlife Service, 1970; E.O. 11990, dated 24 May 1977). Like the woodlands, they are also significant because their number and areal extent have been decreased in favor of agricultural development and other land uses.

Table 11 gives the number and areal extent of wetlands in the North Dakota counties included by the subbasin. The figures were obtained during a 1964 inventory based on a 25 percent sampling of the wetlands within these counties. The number and acreages of all Type 3, 4, 5, 10, and 11 wetlands were multiplied by four to expand the 25 percent sample to 100 percent. Type 1 wetlands were not measured in the 1964 survey. The number and acreages of Type 1 wetlands, however, were estimated based on previous studies, which indicated that they comprise about 60 percent of the total wetland numbers and 10-15 percent of the total wetland acres in the Prairie Pothole Region. Although no acreage figures are available for wetlands drained and converted to cropland, most have been drained in eastern North Dakota. Current annual wetland drainage estimates are thought to be less than two percent of the remaining wetland base, except in isolated areas where it may by higher (U.S. Fish and Wildlife Service, 1979).

As of 1964, a total of 145,818 wetlands representing 437,781 acres remained within the nine counties encompassed by the subbasin's limits.

Table 11

1964 WETLAND INVENTORY DATA FOR THE NINE COUNTIES INCLUDED BY THE DEVILS LAKE SUBBASIN

| | WETLAND TYPES[a] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 3 | | 4 | | 5 | | 10 | | 11 | | TOTAL | |
| County | Number[b] | Acres[c] | Number | Acres | Number | Acres | Number | Acres | Number | Acres | Number | Acres | Number | Acres |
| Walsh | 2,120 | 1,759 | 3,500 | 10,982 | 30 | 700 | 4 | 45 | 0 | 0 | 0 | 0 | 5,654 | 13,486 |
| Cavalier | 10,095 | 5,989 | 16,525 | 36,955 | 292 | 2,940 | 8 | 33 | 0 | 0 | 0 | 0 | 26,920 | 45,917 |
| Ramsey | 10,526 | 12,315 | 16,850 | 46,930 | 609 | 17,714 | 24 | 14,124 | 29 | 816 | 32 | 2,514 | 28,070 | 94,413 |
| Nelson | 7,184 | 6,050 | 10,760 | 16,925 | 1,062 | 12,240 | 104 | 4,844 | 20 | 1,204 | 28 | 5,120 | 19,158 | 46,383 |
| Towner | 7,963 | 5,637 | 12,765 | 29,315 | 439 | 5,025 | 28 | 2,896 | 28 | 182 | 12 | 164 | 21,235 | 43,219 |
| Benson | 9,551 | 7,595 | 8,497 | 25,119 | 566 | 13,690 | 84 | 3,833 | 40 | 1,833 | 64 | 6,160 | 14,802 | 58,230 |
| Eddy | 1,981 | 2,714 | 2,814 | 5,014 | 424 | 6,944 | 40 | 648 | 0 | 0 | 24 | 5,488 | 5,283 | 20,808 |
| Pierce | 2,173 | 9,153 | 2,950 | 17,607 | 252 | 13,592 | 88 | 3,395 | 104 | 1,485 | 228 | 24,943 | 5,795 | 70,175 |
| Rolette | 7,088 | 5,889 | 9,692 | 14,610 | 1,655 | 11,104 | 434 | 11,171 | 4 | 744 | 28 | 1,632 | 18,901 | 45,150 |
| TOTAL | 54,681 | 57,101 | 84,353 | 203,457 | 5,329 | 83,949 | 814 | 40,989 | 225 | 6,264 | 416 | 46,021 | 145,818 | 437,781 |

[a]Type 1 - Seasonally flooded basins and flats.
Type 3 - Shallow fresh marshes.
Type 4 - Deep fresh marshes.
Type 5 - Open fresh water.
Type 10 - Inland saline marshes.
Type 11 - Inland open saline waters.

[b]Calculated at 60 percent of total wetland numbers.

[c]Calculated at 15 percent of total wetland acres.

Source: U.S. Fish and Wildlife Service (1979).

Waterfowl Production Areas

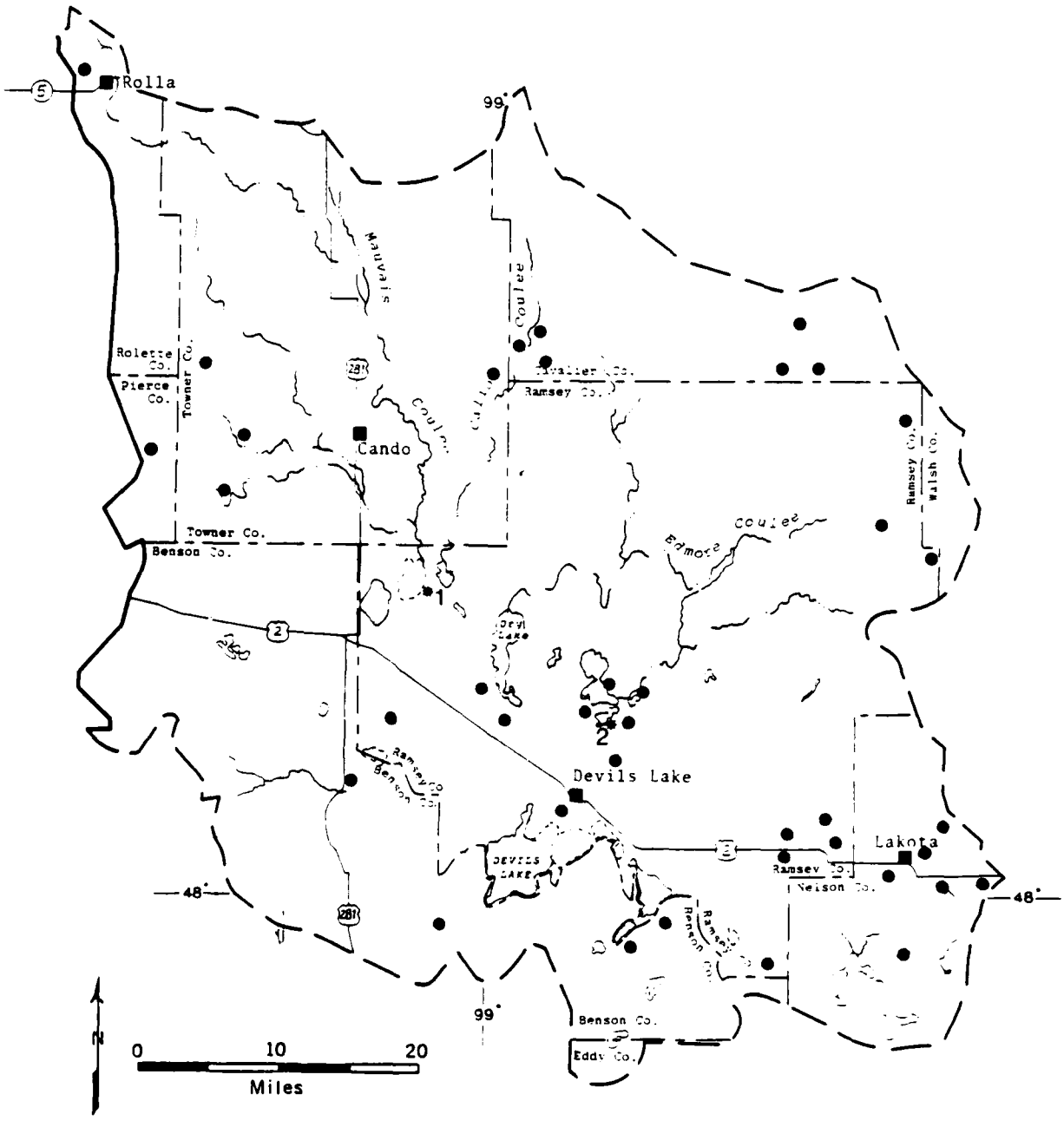
Numerous Federal Waterfowl Production Areas (WPAs) are located within the subbasin. These are wetland areas that the U.S. Fish and Wildlife Service (USFWS) has either acquired through fee title or obtained an easement interest on to preserve valuable breeding, nesting, and feeding habitat for migratory waterfowl. These wetland areas are purchased, or an easement interest obtained, with funds received from the sale of Migratory Bird Hunting and Conservation Stamps ("Duck Stamps"). These WPAs are significant because they provide the public with a great variety of wildlife-oriented recreational opportunities as well as provide valuable habitat for migratory waterfowl and many other forms of wildlife. The USFWS is responsible for the compatibility determinations (uses) and the issuance or denial of permits involving these lands. The approximate locations of these WPAs (fee tracts) within the subbasin are shown in Figure IV. The total acreage figures of all the WPAs and wetland easement areas of the counties included in the subbasin are listed in Table 12. The wetland easement areas are also highly valuable because they provide nesting habitat.

Wildlife Management Areas

Fourteen wildlife management areas are located within the subbasin. A list of these areas and their acreages and locations were presented in the Existing Conditions section for recreation. These areas are significant because of the opportunities provided for outdoor recreation and the protection and management given to biological resources within their confines.

Threatened or Endangered Species

The white-winged scoter is a threatened bird species that formerly nested in the Turtle Hills (Rolette County) and Devils Lake areas. No breeding record has been made of this species in the subbasin since 1960. Three possible reasons have been listed for the decline of this species in North Dakota: (1) egg collecting by amateur and professional ornithologists, (2) excessive hunting pressure, and (3) degradation of water quality in Devils Lake and Stump Lake, the two main concentration areas. Three




● NATURAL AND SCIENTIFIC AREAS

1 Lake Alice
2 Sweetwater Lake Complex

● **WATERFOWL PRODUCTION AREAS (Fee Tracts)**

Exact locations and numbers of Waterfowl Production Areas are on file at the U.S. Fish and Wildlife Service, Area Office, Bismarck. No copies of these maps have been published or released, but can be reviewed at the above office.

Sources: North Dakota State Comprehensive Outdoor Recreation Plan, 1975; Kantrud, 1973.

Figure IV. WATERFOWL PRODUCTION AREAS AND SCIENTIFIC AND NATURAL AREAS

Table 12

WATERFOWL PRODUCTION AREAS (WPAs) AND WETLAND EASEMENT AREAS OF THE COUNTIES INCLUDED IN THE DEVILS LAKE SUBBASIN

| County | WPAs (Acres) | Wetland Easement Areas (Acres) | Total |
|---|---|---|---|
| Benson | 7,186 | 34,658 | 41,844 |
| Cavalier | 9,461 | 13,900 | 23,361 |
| Nelson | 3,053 | 37,885 | 40,938 |
| Pierce | 7,310 | 35,286 | 42,596 |
| Ramsey | 7,700 | 28,481 | 36,181 |
| Rolette | 4,914 | 19,419 | 24,333 |
| Towner | 2,467 | 24,211 | 26,678 |
| TOTAL | 42,091 | 193,840 | 235,931 |

Source: U.S. Fish and Wildlife Service Fee and Easement Interests in Real Property, 1979.

other threatened or endangered bird species are known or presumed to occur in the subbasin: (1) bald eagle, (2) American peregrine falcon, and (3) whooping crane. None of these birds breed within the subbasin, but all three species pass through the area during their annual spring and fall migrations. All three have suffered drastic declines as a result of pressures brought on by civilization such as pesticide pollution and illegal hunting. The timber wolf, fisher, black bear, and American elk are endangered mammal species that have been reported from the area. These species have, to an extent, been extirpated throughout most of their former ranges, primarily because of habitat destruction and hunting or trapping pressures (McKenna and Seabloom, 1979).

Other Important Species

The chestnut-sided warbler, northern waterthrush, mourning warbler, and white-throated sparrow are peripheral species of special interest. These species seem to be restricted in North Dakota to the northeastern counties, especially within the Turtle Hills in Rolette County and in Cavalier County. The Canada lynx is a peripheral mammal that occasionally wanders into the counties included in the subbasin (McKenna and Seabloom, 1979).

Rare and Unique Plants

Barker et al. (no date) compiled a list of North Dakota's rare and unique plants using the distribution records at the North Dakota State University Herbarium. A species was considered rare if three or fewer counties reported the species and if there were only a few individuals at these stations. If there were many individuals at these recording stations and they were widespread in occurrence, the species was listed as unique. The Illinois bundleflower is a rare species that has been reported from the subbasin. This rare legume is normally found in sandy soil along lakes. The bunchberry dogwood is a unique species that requires rich wooded areas. This species was reported from Rolette County, near Rolla.

Natural Areas

Two natural and scientific areas are located within the subbasin (Figure IV). Lake Alice is a 4,500-acre tract of land comprised mostly of wetlands. This area is heavily used by migratory waterfowl. The Sweetwater Lake Complex is a 6,400-acre complex of interconnecting lakes with deciduous woods along the shorelines. This area supports colonial nesting sites for the western grebe, black-crowned night heron, and great blue heron. The area is also extensively used by migrant ducks, geese, and whistling swans (Kantrud, 1973).

# V. FUTURE CONDITIONS

## V. FUTURE CONDITIONS

The following discussion of the subbasin focuses on a presentation of "most probable" and "without project" future economic and population conditions and likely environmental aspects.

### Most Probable Economic Conditions

As required by the Principles and Standards, consideration was given to the adaptation of OBERS Series E and E' projections of general economic and demographic parameters for BEA economic areas 92 and 97 (Grand Forks and Fargo-Moorhead). However, these series were not adopted because recent trends have shown a stabilization and, in the case of several urban communities, a reversal of past steady decreases in population and employment within the subbasin. State, regional and GSRI developed projections are therefore recommended as the most probable statistics. OBERS Series E and E' per capita income and future agricultural activity projections tracked adequately and were thus deemed usable for the purposes of this reconnaissance investigation.

Table 13 presents population, employment and per capita income (expressed in 1979 dollars) figures for the subbasin.

Agriculture accounted for the largest portion of subbasin employment. However, total jobs in agriculture have decreased since 1970 due primarily to new technology and out-migration. Other sectors have compensated for employment losses in agriculture.

### Most Probable Agricultural Conditions

Approximately 1.8 million acres within the subbasin are currently under cultivation, and wheat, barley, sunflowers, and hay are the principal crops produced. Projected total production for these four principal crops through 2030 is presented in Table 14. Estimated total value of the production figures for 1980 is $100.7 million (Using October 1979 Current Normalized Prices for North Dakota). By the year 2030, the total value of production is estimated at $169.1 million (Using October 1979 Current Normalized Prices for North Dakota).

Table 13

DEVILS LAKE SUBBASIN POPULATION, EMPLOYMENT AND
PER CAPITA INCOME PROJECTIONS
(1980-2030)

| Parameter | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1970 | 1977 | 1980 | 1990 | 2000 | 2010 | 2020 | 2030 |
| Population | 27,110 | 28,046 | 28,500 | 29,100 | 29,700 | 30,200 | 30,800 | 31,506 |
| Employment | 9,489 | 12,340 | 12,500 | 12,800 | 13,100 | 13,300 | 13,600 | 13,900 |
| Per Capita Income (1979 Dollars) | 5,895 | 7,242 | 8,800 | 11,400 | 14,900 | 19,300 | 25,100 | 32,700 |

Sources: U.S. Water Resources Council, 1972 Projections, Series E; Devils Lake Basin Study, Devils Lake Basin Advisory Committee, 1976; and Gulf South Research Institute.

Table 14

DEVILS LAKE SUBBASIN, PRINCIPAL CROPS AND PROJECTED PRODUCTION 1980-2030
(Production in Thousands)

| Year | Wheat (Bushels) | Barley (Bushels) | Sunflowers (Pounds) | Hay (Tons) |
|---|---|---|---|---|
| 1980 | 19,640 | 12,452 | 127,760 | 177 |
| 1990 | 22,783 | 14,443 | 148,202 | 205 |
| 2000 | 25,925 | 16,435 | 168,644 | 233 |
| 2010 | 27,889 | 17,680 | 181,420 | 251 |
| 2020 | 29,853 | 18,926 | 194,196 | 268 |
| 2030 | 32,996 | 20,918 | 214,637 | 297 |

Sources: OBERS Series E'; and Gulf South Research Institute.

Evaluation of Flood Damages--Future Conditions

A summary of present and future average annual damages is presented in Table 15. Assuming a discount rate of 7 1/8 percent, average annual equivalent damages are $3.2 million. Rural damages account for over 99 percent of this figure, with urban damages accounting for the remainder.

Flood damages to residences, businesses, industrial structures, churches, schools, automobiles, house trailers, public property and contents are included in the urban damages category. Damages to streets and utilities (including water, gas, electricity, sanitary sewers, storm sewers, and telephone systems) are also taken into consideration. This category also includes loss of wages, loss of profits, expenditures for temporary housing, cleanup costs, and extra expenses for additional fire and police protection and flood relief.

Agricultural flood damages consist of crop and pasture damage, which may include costs of replanting, refertilizing, additional spraying, reduced crop yields, loss of animal pasture days, and other related flood losses.

Other agricultural damages consist of land damage from scour and gully erosion and deposition of flood debris; livestock and poultry losses; damages to machinery and equipment, fences, and farm buildings and contents (excluding residences); and damages to irrigation and drainage facilities.

Table 15

DEVILS LAKE SUBBASIN, SUMMARY OF PRESENT AND FUTURE AVERAGE ANNUAL DAMAGES,
URBAN, AGRICULTURAL, AND TRANSPORTATION
(October, 1979 Prices, 7 1/8 Percent Interest)

| | Flood Damages | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Category | 1980 | 1990 | 2000 | 2010 | 2020 | 2030 | Increase 1980-2030 | Average Annual Equivalent Factor | Average Annual Equivalent of Increase | Equivalent Average Annual Damages |
| Urban | 2,600 | 2,900 | 3,100 | 3,400 | 3,600 | 3,900 | 1,300 | 0.2903 | 400 | 3,000 |
| Agricultural | | | | | | | | | | |
| Crop | 1,931,200 | 2,240,200 | 2,549,200 | 2,742,300 | 2,935,400 | 3,244,400 | 1,313,200 | 0.2903 | 381,200 | 2,312,400 |
| Other Agricultural | 643,700 | 695,200 | 746,700 | 778,900 | 811,100 | 862,600 | 218,900 | 0.2903 | 63,500 | 707,200 |
| Transportation | 194,000 | 194,000 | 194,000 | 194,000 | 194,000 | 194,000 | -- | -- | -- | 194,000 |
| TOTAL | 2,771,500 | 3,132,300 | 3,493,000 | 3,718,600 | 3,944,100 | 4,304,900 | 1,533,400 | 0.2903 | 445,100 | 3,216,600 |

Source: Gulf South Research Institute.

Transportation damages include all damages to railroads, highways, roads, airports, bridges, culverts, and waterways not included in urban damages. In addition, all added operational costs for railroads and airlines and vehicle detours are included.

Future growth of urban flood damages was estimated to be an uncompounded (straight-line) rate of one percent per year for a 50-year period beginning in the base year, with no growth thereafter.

Agricultural crop flood damages were projected to increase at the same rate as crop income projections published in the 1972 OBERS Series E projection report. These crop income projections were prepared by the U.S. Economic Research Service (ERS) for the Red River of the North region. Other agricultural flood damages were projected to increase at one-half of this rate.

Transportation damages are not expected to change throughout the project life because of the long-term economic life associated with such structures as bridges, railways, roads, and culverts. In addition, it has been found that repairs to these types of structures rarely exceed the cost of a new structure, even with frequent flooding.

Most Probable Environmental Conditions

Improvements in water quality will occur with successful implementation of point and nonpoint source pollution abatement programs. The nonpoint source program will take substantially longer to implement. These improvements will benefit aquatic biota, as well as wildlife that utilize aquatic habitats. Freshwater conditions will persist in portions of Devils Lake as long as wetland drainages continue at their present magnitude, which is beneficial to the freshwater fisheries, but occurs at the expense of valuable wetlands.

Woodland acreage will diminish unless the state is successful in obtaining ownership of the native forests in the subbasin. This problem was discussed in the Problems and Needs section. Wetland drainages will continue, as indicated in the preceding paragraph, resulting in reduced numbers and areal extent of this significant and fragile resource. Commensurate with the reduction of woodlands and wetlands is the decrease in plant and animal populations associated wholly or in part with these habitat types.

Without Project Conditions

It is anticipated that the conditions that will prevail over the 50-year planning period in the absence of a plan to alter resource management procedures will be the same as those set forth previously under the most probable future scenario.

# VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAM

# VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

## Institutions

The development of effective water resources management practices in the subbasin is affected by a large number of Federal, state, and local agencies involved in project planning and implementation. There are 44 Federal agencies with various types of jurisdictions and 14 directly involved in the water and related land resource planning process. At the state level, seven agencies are involved. There are also regional commissions, county agencies, and municipal entities. Differences in perspective and problems of coordination hamper the effective and speedy resolution of problems.

The primary local agencies involved in water resources management in the subbasin are the eight water management districts representing Rolette, Towner, Cavalier, Ramsey, Walsh, Nelson, Benson, and Eddy counties. The Joint Water Management Board has implemented flood control projects in the subbasin. The districts have broad powers to develop and implement programs related to flood control, water supply, water conservation, and other problems concerning water resources management. In addition, each of the above mentioned counties has a soil conservation district with authority in the subbasin. The large number of agencies with jurisdiction in the subbasin impedes efficient planning for the subbasin. There is at present no water resource management plan which addresses the flooding concerns of the subbasin as a single hydrological unit.

The major Federal agencies with water resource development interests in the area are the Soil Conservation Service (SCS) and the Corps of Engineers. The Soil Conservation Service has developed one measure for Starkweather Watershed but it is not completed. The Corps of Engineers, SCS, the North Dakota State Water Commission, the eight water management districts and eight soil conservation districts with jurisdiction in the subbasin, the Devils Lake Basin Joint Water Management Board, and the towns of Devils Lake, Starkweather, and Edmore should be consulted in flood control planning in the subbasin. In addition, the Bureau of Indian Affairs and the Tribal Councils representing Fort Totten and Turtle Mountain Indian Reservations should be consulted if flood control measures are developed which impact Indian lands.

It should be noted the North Central Planning Council and Red River Regional Planning Council have developed comprehensive land use plans that include the subbasin area.

Structural Measures

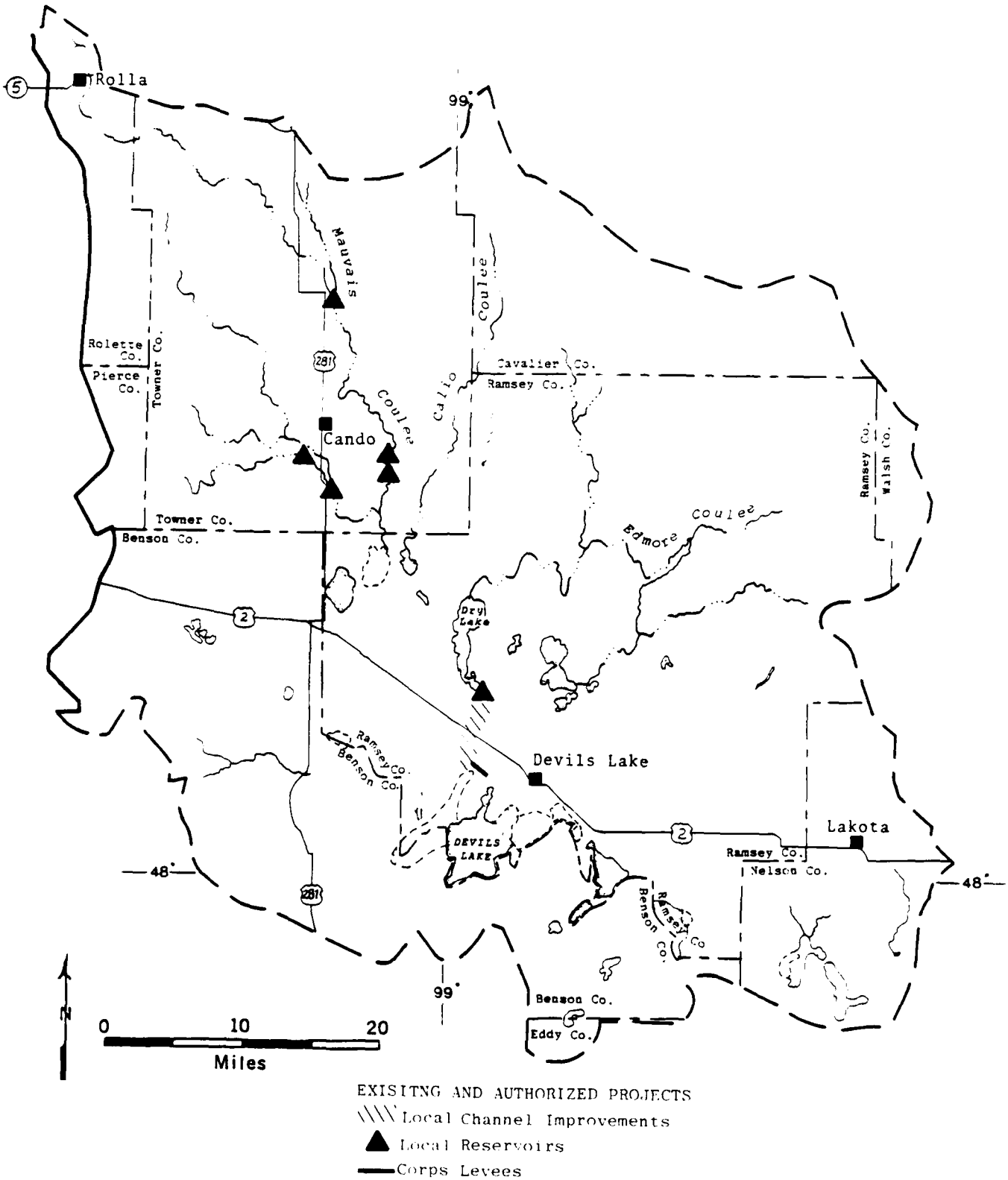
A channel connecting Dry Lake with Sixmile Bay was completed in 1978. Constructed under the auspices of the Devils Lake Basin Joint Water Management Board, this channel is about four miles long and is designed for a maximum flow of 500 cfs during periods of high water on Dry Lake. This channel is plugged at the present time, however, pending a legal decision as to what agency has regulatory jurisdiction over the operation of the channel.

As an emergency measure in the spring of 1979, the Corps of Engineers, in cooperation with the State Water Commission and the City of Devils Lake, raised "Dump Road", which follows a north-south alignment about two miles west of Devils Lake between the city's sanitary lagoons and the airport at the head of Creel Bay. Interior drainage was discharged by temporary pumps through an upper culvert when the lake elevation precluded gravity flow through a low culvert.

The North Dakota State Highway Department plans to raise or relocate low sections of Highways 19, 20, and 57 in the vicinity of Devils Lake. Plans provide for raising roadway grades to elevation 1,440, which will allow five feet of freeboard for wave action and surge effects above a design lake elevation of 1,435. Two alternate routes for Highway 20 are under consideration, both of which would follow Highway 57 to a point about 1.5 miles south of the present junction and then follow an eastward route either between the two water areas of Mission Bay or south of both lakes. Since 1975, the Highway Department has expended $500,000 protecting and raising state highways in the Devils Lake area, and estimates for the current program place the cost between $5 and $6 million.

Control structures for lake outlets and dams, constructed primarily for recreational and wildlife purposes, are located in the subbasin. None of these facilities provide any significant flood protection.

Existing flood damage reduction measures are shown in Figure V.




Source: Gulf South Research Institute.

Figure V. EXISTING FLOOD CONTROL MEASURES

Nonstructural Measures

Nonstructural flood control measures are measures that reduce or eliminate flood damages through procedures that involve little if any construction effort. Typically, these types of measures will include flood warning and emergency protection, floodplain zoning and regulation, flood insurance, flood proofing, and floodplain evacuation. These measures are primarily applicable to urban areas.

The towns in the subbasin participate in the Red River Valley flood warning system. The flood warning system for the Red River Valley is a cooperative network organized by the National Weather Service in Fargo, North Dakota. Fifty volunteers throughout the basin report to the National Weather Service on a weekly basis during winter and fall and on a daily basis during spring and summer. The reportage covers all precipitation of 0.1 inch or more, including amounts of snow and water equivalent. This information is transmitted to the River Forecasting Center in Minneapolis, where it is run through a computer system to determine probable flood stages. The predictions are then transmitted to the National Weather Service in Fargo, which releases them to the public through the news media. Communities are then able to engage in emergency actions to protect themselves from flood damages. Contacts with local officials indicate the flood warning system generally works quite well in the subbasin.

Floodplain regulations and flood insurance are currently required by Federal policies and encouraged by the State of North Dakota. Floodplain regulation is the regulation of any new developments in existing floodplain areas, thereby preventing or reducing future flood damages. However, because home and business owners in flood prone areas can obtain structural improvement loans through the purchase of flood insurance and because the value of the contents of these structures is expected to increase, flood damages will increase in the short run even with floodplain regulations in effect.

There are other types of measures that could be implemented in the subbasin to reduce flood damages but that are not directly applicable to urban areas. These measures would include such things as land treatment

programs, use of present drainage ditches for floodwater storage, and use of natural areas for reversion to water retention use. Land treatment is used by some farmers in the subbasin in cooperation with the Soil Conservation Service (SCS), but exact participation rates are unavailable.

Adequacy of Existing Measures

"Dump Road" was raised to elevation 1,432. The Devils Lake water level has shown a steady increase since about 1970, reaching an elevation of 1,427 in 1979. If this trend continues as anticipated, the road barrier will be unable to prevent flooding of about a 2-to 3-square mile area bordering on the southwest side of the city of Devils Lake.

The channel from Dry Lake to Sixmile Bay, while providing an outlet from Dry Lake and alleviating flood problems in the Starkweather and Edmore Watersheds, could compound the problem at Devils Lake. Since there is no outlet from Devils Lake, discharges from Dry Lake, if not properly regulated, could result in the water level of Devils Lake reaching the critical stage sooner than anticipated. An outlet from Devils Lake would eliminate this possibility.

# VII. CRITERIA AND PLANNING OBJECTIVES

# VII. CRITERIA AND PLANNING OBJECTIVES

## Floodplain Management Criteria

Technical, economic, and environmental criteria must be considered when formulating and evaluating alternative floodplain management measures for the subbasin.

The technical criteria used in formulating and evaluating alternatives for this report consisted of the application of appropriate engineering standards, regulations, and guidelines.

Economic criteria entailed the identification and comparison of benefits and costs of each measure. Tangible economic benefits must exceed costs; however, in certain instances, considerations of appropriate gains in the other accounts (environmental quality, social well-being and regional development) could alter this requirement. All alternatives considered are scaled to a design which optimizes net benefits. Annual costs and benefits are based on an interest rate of 7 1/8 percent and price levels and conditions existing in October 1979. A 50-year amortization schedule is used for the features considered.

Environmental considerations call for the formulation of measures that minimize objectionable or adverse environmental effects and maximize environmental benefits. Also, limited consideration was given to modifications based on coordination with state and Federal agencies, local interests, and citizen groups.

## Planning Objectives

The primary planning objective of this study was to contribute to flood reduction needs in the subbasin and thereby provide protection from or reduction of flood losses. In conjunction with this economic objective, the study attempted to develop contributions to the environmental quality of the subbasin.

The development of planning objectives involved a broad-range analysis of the needs, opportunities, concerns, and constraints of the subbasin. On the basis of the identified problems, needs, and desires, the following planning objectives were established:

(1) Contribute to protection from and prevention, reduction, or compensation of flood losses for the flood prone areas of the subbasin during the period of analysis.

(2) Contribute, to the maximum extent possible, to the preservation of the quality of the existing riverine environment and enhance the environmental potential of the subbasin as a whole.

(3) Contribute to the enhancement of recreational opportunities, particularly in the northern part of the subbasin.

(4) Contribute to the improvement of water quality in Devils Lake.

(5) Contribute to the improvement of ground water supplies throughout the subbasin.

(6) Contribute to the reduction of wind and water erosion throughout the subbasin.

(7) Contribute to the developing trend toward increased irrigation throughout the subbasin by the improvement of ground water quality and supply.

(8) Contribute to the reduction of wastewater management problems, particularly insofar as they relate to water quality.

(9) Contribute to the development of small hydroelectric installations in the subbasin.

# VIII. FORMULATION OF ALTERNATIVE MEASURES

# VIII. FORMULATION OF ALTERNATIVE MEASURES

This section contains discussions of the management measures that have been identified to meet the resource planning objectives relative to the resolution of flooding problems. Reviews of existing studies on selected watersheds in the subbasin and on the subbasin itself revealed that the flooding problems in the subbasin have been defined, and measures to alleviate these problems have been identified.

The following measures, which are illustrated in Figure VI, were obtained from existing studies:

1. A study of the subbasin for the Devils Lake Basin Advisory Committee in October, 1976 presents several alternatives for flood reduction measures. For purposes of this study, the subbasin was subdivided into nine watersheds and analyzed on the basis of individual watersheds and then collectively where logical and practical. Devils Lake Watershed was not analyzed in this study, but the potential for flooding problems at the city of Devils Lake is currently being investigated by the Corps of Engineers. Also, in this study all channels were analyzed and/or designed for an eight-year frequency peak runoff, which was agreed upon as the level of protection for agricultural land.

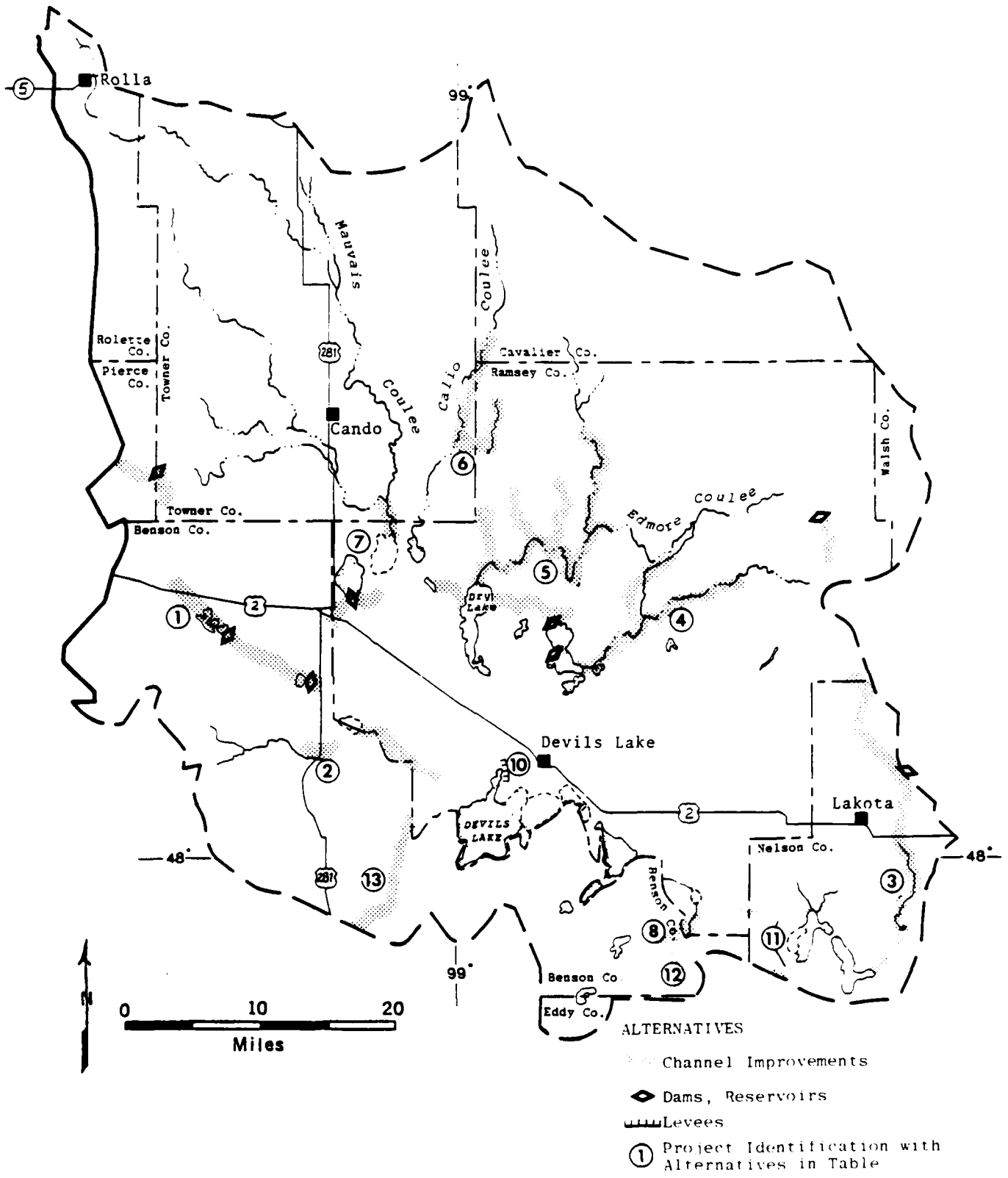
Flood damage reduction measures for the respective watersheds are as follows:

a. Hurricane Creek Watershed: Proposed improvements consist of approximately 24 miles of channel improvement, two new lake control structures, modification of one existing lake control structure, and the necessary treatment measures for watershed protection.

b. Comstock Watershed: Improvements consist of about five miles of channel improvement, one grade stabilization structure, and the necessary treatment measures for watershed protection.

c. Stump Lake Watershed: Improvements consist of approximately 26 miles of channel improvement, one lake control structure, two control structures on sloughs, and the necessary treatment measures for watershed protection.

d. Edmore Watershed: The topography of this watershed is not suitable for floodwater retarding structures; therefore, channel improvements offer the alternate measure for flood control. Improvements in the watershed consist of approximately 55 miles of channel improvements, grade stabilization structures, and the necessary treatment measures for watershed protection.




Source: Gulf South Research Institute.

Figure VI. ALTERNATIVE FLOOD CONTROL MEASURES

e. Starkweather Watershed: Studies indicated that coordination of land treatment measures supplemented by approximately 56 miles of channel improvements are the only economical means of meeting project objectives. The topography in this watershed does not lend itself to floodwater retarding structure sites.

f. Chain Lakes Watershed: Improvements consist of about 24 miles of channel improvement and new channel construction, two lake control structures, and the necessary treatment measures for watershed protection.

g. Mauvais Coulee Watershed: Improvements consist of approximately 19 miles of channel improvements, one new lake control structure, the upgrading and replacement of roadway openings with insufficient capacity, and the necessary treatment measures for watershed protection.

h. South Slope Watershed: Improvements consist of approximately three miles of channel improvements, four grade stabilization structures, and the necessary treatment measures for watershed protection.

The construction of these structural measures will result in a reduction in flood related damages of about 45 percent.

2. A flood control reconnaissance report on the Devils Lake Watershed was completed by the Corps of Engineers in February, 1980. This report presented alternatives to alleviate the high water problems caused by record runoffs into Devils Lake. Presently, there is no outlet from Devils Lake; consequently, the reconnaissance study developed and analyzed six possible outlet alternatives and presented preliminary cost estimates for three of the more plausible alternatives.

   The first of the three alternatives would withdraw water from West Bay and would require two pump stations, about 11.6 miles of new channel, and several drop structures on a tributary coulee of the Sheyenne River. The second alternative would withdraw water from East Devils Lake and, with one pump station having a 40-foot lift, would require about 12 miles of channel to outlet in Tolna Coulee. The third alternative would involve a connecting channel between East Devils Lake and Western Stump Lake and another gravity flow channel from Western Stump Lake to Tolna Coulee, a distance of about two miles.

   All alternatives result in the ultimate discharging of the water from Devils Lake into the Sheyenne River. Two problems will have to be resolved in selecting an alternative to prevent excessive levels being reached on Devils Lake by

transferring surplus water to the Sheyenne River. The first problem is the difficulty in forecasting when and at what elevation Devils Lake might attain its highest level; and the second, more serious, problem is the high salinity of the Devils Lake water, which increases from West Bay to East Devils Lake and is particularly high in eastern Stump Lake.

While these problems are being resolved, an immediate, more pressing need, that of preventing flood damage in the city of Devils Lake, can be met by raising a road at the head of Creel Bay. Raising about 2.5 miles of a road, referred to as "Dump Road", at the head of Creel Bay and installing facilities to accommodate pumps for interior drainage offers the best early action solution to the immediate threat of flooding in parts of the city of Devils Lake and direct discharge of sewage into the lake.

3. Construction of levees around farmsteads, averaging 5.0 acres in size would provide protection against a 1.0 percent (100-year) frequency flood. These could be constructed by SCS, the Corps, or private individuals.

4. Nonstructural alternatives consist of land treatment of about 530,000 acres throughout the subbasin. Besides protecting the soil and sustaining production of food and fiber, these measures will increase infiltration, thereby reducing flooding Implementation of these measures can be expected to reduce floodwater damages by four percent.

Engineering Methodology

Since all alternatives were developed in prior reports and no additional alternatives were formulated in this study, the technological aspects of the various alternatives were not investigated. However, cost estimates were updated and revised as necessary. Cost estimates were updated to October, 1979 price levels based on Engineering News Records' construction cost indexes.

Pump station costs in the Corps' report for the alternatives relating to an outlet for Devils Lake were revised. Bases for these revisions were: (1) that these installations would be permanent type facilities; and (2) that dewatering operations along with cofferdams would be required in their construction.

Nonstructural Measures

Among the nonstructural measures considered were flood warning and forecasting services, emergency protection measures, permanent floodplain evacuation and flood proofing, floodplain regulation and flood proofing. These measures are discussed in the following paragraphs.

Floodplain regulation and flood insurance are currently required by Federal policies and encouraged by the State of North Dakota. This measure primarily consists of regulating new development in existing floodplain areas and the insuring of affected property owners for losses from flood damages. Floodplain regulation should be a part of any flood protection system and could be effective in this subbasin. As a supplement to floodplain regulation, flood insurance could provide limited protection to existing developments. In the long run, floodplain regulation would theoretically eliminate all nonconforming floodplain structures, thereby reducing flood damages.

Unsubsidized crop insurance is available through the U.S. Department of Agriculture Federal Crop Insurance program, which covers all natural disasters including floods. However, actual crop damages could be reduced only to the extent that intensive farming practices would be discouraged in the long run in the floodplain. Because of the highly productive nature of the floodplain, it is very doubtful that any long-term shifts away from intensive farming of floodplain areas would occur.

Flood warning and forecasting services in conjunction with emergency protection measures have been used with reasonable success. Evacuation is possible due to the prolonged nature of the rise of flood waters from major flood events; but particularly in the case of summer floods, time would not permit the erection of emergency flood protection works. The broad extent of the floodplain, the large number of persons involved, and the unavailability of facilities in neighboring communities to accommodate affected persons preclude this alternative from being economically or socially acceptable as an effective means of solving flooding problems in the subbasin. However, it is recommended that flood warning and forecasting services be continued in order to alert floodplain residents of impending dangers.

Permanent evacuation of flood prone areas would consist of the acquisition of lands, relocation of improvements and resettlement of the population, ultimately resulting in the conversion of land use to a state less susceptible to flood damages. Impacts of this alternative would primarily be cultural and economic in nature. Flood proofing would involve structural changes and adjustment to properties in an effort to reduce or eliminate flood damages. This is most effective when applied to new construction, but can be applied to existing structures in some instances. Permanent evacuation would result in the disruption of long-established social and cultural relationships, but could eliminate flood damages to structural units, providing that floodplain regulations were enforced. Furthermore, health and safety of floodplain residents would be enhanced, and natural habitats would be improved. However, the residual damages to agriculture and the economic, social and cultural impacts of these two measures would more than offset the benefits.

The preceeding discussion summarizes the results of prior Corps of Engineers investigations. In addition to the nonstructural measures mentioned in the Corps reports, there is an opportunity for the use of land treatment measures throughout the subbasin that help to contain water on land as well as reducing runoff-related erosion damages. Other measures would include, but not be limited to, water retention in existing ditches and preservation of natural retention areas. These would need to be identified and retention capabilities would need to be determined. Wetland restoration could also be considered, where appropriate, for water retention.

# IX. ASSESSMENT OF ALTERNATIVES

# IX. ASSESSMENT OF ALTERNATIVES

## Economic Assessment

Damages to crops and other agricultural assets are by far the primary flood problems in the subbasin. Flood waters overtop the banks of the low capacity channels and inundate thousands of acres of adjacent cropland. The floodplains are broad areas of land adjacent to and between the lakes. Also isolated areas adjacent to stream channels in the upper reaches are subject to frequent flooding.

The economic evaluation of the flood control alternatives for the subbasin is presented in Table 16. Since all alternatives were developed in prior reports and no additional alternatives were formulated in the study, the average annual benefits estimated in those reports were updated to October 1979 levels.

Alternative one consists of approximately 24 miles of channel improvements, two new lake control structures, modification of one existing lake control structure, and the necessary treatment measures for watershed protection. Economic evaluation of this alternative yielded a benefit/cost ratio of 2.15.

Alternative two consists of approximately five miles of channel improvement, one grade stabilization structure, and the necessary treatment measures for watershed protection. Economic evaluation of this alternative yielded a benefit/cost ratio of 2.23.

Alternative three consists of approximately 26 miles of channel improvement, one lake control structure, two control structures on sloughs, and the necessary treatment measures for watershed protection. Economic evaluation of this alternative yielded a benefit/cost ratio of 2.22.

[illegible] consists of approximately 55 miles of channel improvements, [illegible] structures, and the necessary treatment measures for [illegible]. Economic evaluation of this alternative yielded [illegible] 1.27.

[illegible] consists of approximately 56 miles of channel improvements [illegible] treatment measures. Economic evaluation of this [illegible] benefit/cost ratio of 1.00.

## Table 16

## ECONOMIC EVALUATION OF ALTERNATIVES

| Alternatives | Acres Protected | Average Annual Acres | Capital Costs | Average Annual Costs | Average Annual Rural Benefits | Average Annual Urban Benefits | Total Average Annual Benefits | B/C Ratio |
|---|---|---|---|---|---|---|---|---|
| 1. Hurricane Lake Watershed | -- | -- | 999,800 | 73,600 | -- | -- | 158,200[1] | 2.15 |
| 2. Comstock Watershed | -- | -- | 193,000 | 14,200 | -- | -- | 31,700[1] | 2.23 |
| 3. Stump Lake Watershed | -- | -- | 1,451,000 | 106,800 | -- | -- | 237,300[1] | 2.22 |
| 4. Elmore Watershed | -- | -- | 4,651,000 | 342,400 | -- | -- | 435,100[1] | 1.27 |
| 5. Starkweather[2] Watershed | -- | -- | 10,046,000 | 739,500 | -- | -- | 737,800 | 1.00 |
| 6. Chain Lakes Watershed | -- | -- | 9,007,000 | 668,200 | -- | -- | 170,100[1] | 0.25 |
| 7. Mauvais Coulee Watershed | -- | -- | 1,996,000 | 146,900 | -- | -- | 187,600[1] | 1.28 |
| 8. South Slope Watershed | -- | -- | 382,000 | 28,100 | -- | -- | 79,100[1] | 2.81 |
| 9. Land Treatment[3] | -- | -- | 7,016,000 | 516,400 | -- | -- | 266,100[1] | 0.52 |
| 10. Raise "Dump Road" at the Head of Creel Bay | -- | -- | 1,660,100 | 122,200 | -- | -- | --[4] | -- |
| 11. Devils Lake Outlet[5] Channel | -- | -- | 13,669,000 | 1,006,200 | -- | -- | 3,000,000[8] | -- |
| 12. Devils Lake Outlet[6] Channel | -- | -- | 6,386,000 | 470,100 | -- | -- | 3,000,000[8] | -- |
| 13. Devils Lake Outlet[7] Channel | -- | -- | 14,383,000 | 1,058,700 | -- | -- | 3,000,000[8] | -- |
| 14. Farmstead Levees (Per Levee) | -- | -- | 5,600 | 400 | 840 | -- | 840 | 2.10 |

[1] Available information did not make the distinction between urban and rural benefits.

[2] Includes nonstructural measures.

[3] Includes land treatment measures for Hurricane Lake, Comstock, Stump Lake, Edmore, Chain Lakes, Mauvais Coulee, Devils Lake, and South Slope Watersheds.

[4] No benefit information was available for this alternative.

[5] Devils Lake Outlet Channel via Stump Lake to Tolna Coulee.

[6] Devils Lake Outlet Channel via East Devils Lake to Tolna Coulee.

[7] Devils Lake Outlet Channel via West Bay through Round, Long, and Stony Lakes.

[8] This figure does not represent average annual benefits, but the benefits that can be claimed by preventing the water level in the lake from reaching an elevation of 1,435.

Source: Gulf South Research Institute.

Alternative six consists of 24 miles of channel improvement and new channel construction, two lake control structures, and necessary treatment measures for watershed protection. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.25.

Alternative seven consists of approximately 19 miles of channel improvement, one new lake control structure, the upgrading and replacement of roadway openings with insufficient capacity, and the necessary treatment measures for watershed protection. Economic evaluation of this alternative yielded a benefit/cost ratio of 1.28.

Alternative eight consists of approximately three miles of channel improvements, four grade stabilization structures, and the necessary treatment measures for watershed protection. Economic evaluation of this alternative yielded a benefit/cost ratio of 2.81.

Alternative nine consists of land treatment measures for the following watersheds: Hurricane Lake, Comstock, Stump Lake, Edmore, Chain Lakes, Mauvais Coulee, Devils Lake, and South Slope. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.52.

Alternative 10 consists of raising about 2.5 miles of road, referred to as "Dump Road", at the head of Creek Bay and installing facilities to accommodate pumps for interior drainage. Benefits from the implementation of this alternative would include flood protection for parts of the city of Devils Lake and the prevention of the direct discharge of sewage into Devils Lake. No dollar estimates for the degree of protection provided by this alternative were available, and therefore no benefit/cost ratio could be derived.

Alternative 11 is a Devils Lake Outlet Channel via Stump Lake to Tolna Coulee. Water would be withdrawn from West Bay and would require two pump stations, about 11.6 miles of new channel, and several drop structures on a tributary coulee of the Sheyenne River.

Alternative 12 is a Devils Lake Outlet Channel via East Devils Lake to Tolna Coulee. Water would be withdrawn from East Devils Lake, and with one pump station having a 40-foot lift, would require about 12 miles of channel to outlet on Tolna Coulee.

Alternative 13 is a Devils Lake Outlet Channel via West Bay through Round, Long, and Stony Lakes. This would involve a connecting channel between East Devils Lake and Western Stump Lake and another gravity flow channel from Western Stump Lake to Tolna Coulee, a distance of about two miles.

Alternative 14 involves the construction of levees around individual farmsteads. The levees would provide protection against a one percent (100-year) frequency flood. Economic evaluation of this alternative yielded a benefit/cost ratio of 2.10.

Impact Assessment

Table 17 provides a generalized assessment of anticipated impacts on various key elements of the study area resulting from each of the 14 alternative measures being considered.

Hurricane Lake Watershed, Comstock Watershed, Stump Lake Watershed, Edmore Watershed, Starkweather Watershed, Chain Lakes Watershed, Mauvais Coulee Watershed, and South Slope Watershed

Channel improvements, grade stabilization structures, and necessary treatment measures would yield minimally beneficial social and economic effects for the Comstock, Chain Lakes, and South Slope watersheds. All of the other watersheds would have moderately beneficial social and economic effects due to channel improvements and other flood control measures such as lake control structures, grade stabilization structures, land treatment, and new channel construction. All of the watersheds would experience maximally adverse biological effects and moderately adverse effects on water quality. It is not known what effects would take place with respect to land use, water supply, and cultural elements, while minimally adverse effects would occur for recreation in the watersheds.

Devils Lake Outlet Channels I, II, and III

Channelization involved in each of these alternatives would yield maximally beneficial social and economic effects, but the effects on biological elements would be maximally adverse. Water quality would have moderately adverse effects as a result of the construction of outlet channels. It is not known what effects would take place with respect

## Table 17

## ASSESSMENT OF MEASURES BY RESOURCE ELEMENT, DEVILS LAKE SUBBASIN

| Measures | Social | Economics | Land Use | Biology | Water Quality | Water Supply | Cultural | Recreation |
|---|---|---|---|---|---|---|---|---|
| Hurricane Lake Watershed | MoB | MoB | NKE | MaA | MoA | NKE | NKE | MiA |
| Comstock Watershed | MiB | MiB | NKE | MaA | MoA | NKE | NKE | MiA |
| Stump Lake Watershed | MoB | MoB | NKE | MaA | MoA | NKE | NKE | MiA |
| Elmore Watershed | MoB | MoB | NKE | MaA | MoA | NKE | NKE | MiA |
| Starkweather Watershed | MoB | MoB | NKE | MaA | MoA | NKE | NKE | MiA |
| Chain Lakes Watershed | MiB | MiB | NKE | MaA | MoA | NKE | NKE | MiA |
| Mauvais Coulee Watershed | MoB | MoB | NKE | MaA | MoA | NKE | NKE | MiA |
| South Slope Watershed | MiB | MiB | NKE | MaA | MoA | NKE | NKE | MiA |
| Land Treatment | MiB | MiB | MiB | MoB | MoB | NKE | NKE | MiB |
| Raise "Dump Road" at the Head of Creel Bay | MiB | MaB | NKE | MoA | MiB | NKE | NKE | NKE |
| Devils Lake Outlet Channel I | MaB | MaB | NKE | MaA | MoA | NKE | NKE | MiA |
| Devils Lake Outlet Channel II | MaB | MaB | NKE | MaA | MoA | NKE | NKE | MiA |
| Devils Lake Outlet Channel III | MaB | MaB | NKE | MaA | MoA | NKE | NKE | MiA |
| Farmstead Levees | MiB | MiB | NKE | NKE | NKE | NKE | NKE | NKE |

Note: NKE = No Known Effect
MiA = Minimally Adverse
MoA = Moderately Adverse
MaA = Maximally Adverse
MiB = Minimally Beneficial
MoB = Moderately Beneficial
MaB = Maximally Beneficial

Source: Gulf South Research Institute.

to land use, water supply, and cultural elements, but minimally adverse recreation effects would result.

Land Treatment

Land treatment of more than 500,000 acres in the subbasin would result in minimally beneficial effects for social, economic, land use, and recreation elements. Both biological and water quality elements would be moderately benefited, but it is not known to what extent water supply and cultural elements would be affected.

Raise "Dump Road" at the Head of Creel Bay

Raising part of "Dump Road" and installing pumps for interior drainage would result in minimally beneficial social and maximally beneficial economic effects for the city of Devils Lake. These same measures would result in minimally beneficial water quality effects and moderately adverse biological effects. It is not known what effects these flood control measures would have on land use, water supply, cultural, and recreation elements.

Farmstead Levees

Minimally beneficial social and economic effects would result from the protection of several farmsteads in the 100-year floodplain. All the other resource elements would not be significantly affected, although consideration must be given to public health and aesthetic factors prior to their construction.

# X. EVALUATION

# X. EVALUATION

Many of the alternatives considered for the subbasin have benefit/cost ratios that equal or exceed unity. The two that do not are land treatment for eight watersheds and channel improvements and control structures for the Chain Lakes Watershed. Alternative 12, which involves an outlet channel for Devils Lake, would maximize economic benefits for the subbasin. However, the effects on biological elements would be maximally adverse.

National Economic Development (NED) and Environmental Quality (EQ) plans will be tentatively formulated in association with the Red River of the North Basin reconnaissance report.

# XI. ADDITIONAL STUDY NEEDS

## XI. ADDITIONAL STUDY NEEDS

This report was developed almost entirely on the basis of secondary information from readily available planning documents. Data available from state and Federal agencies were not fully canvassed, and only a limited number of calls were made to the area. In particular, state university libraries and department resources could not be fully utilized. Thus, the document aims only at a broad-brush perspective. In order to provide a more detailed and in-depth analysis of subbasin resources, problems, and potential solutions, the following additional study needs would have to be fulfilled:

1. A literature search should be conducted to obtain available biological data for the subbasin. Fieldwork should be planned to fill in any data gaps which exist with the end result of obtaining good baseline data for the subbasin. This includes those areas where new flood control measures have been proposed, as well as updating any data for those projects which have been previously studied.
2. Areas of high environmental quality (e.g., prairie remnants) should be identified and inventoried within the subbasin.
3. Updated knowledge of the location, areal extent, and types of wetlands occurring within the specific subbasin boundaries would be extremely useful in determining whether wetland restoration would assist in alleviating flooding problems, as has been indicated by Cernohous (1979), and would provide a comparison for documenting wetland losses since the 1964 inventory.
4. Primary water and sediment quality data need to be obtained or updated to characterize baseline conditions in the waterbodies of the subbasin, particularly in those areas where flood control measures have been proposed.
5. Information pertaining to wastewater management needs to be updated.
6. The information obtained in items 1-5 above would provide an important data base upon which an impact evaluation of proposed flood control measures can be performed and would provide information relative to the cumulative effects of flood control projects on environmental resources in the subbasin. These projects include those that are in-place or proposed.
7. Nonstructural flood damage reduction measures should be thoroughly explored such as those listed below.

- Establishment of buffer areas and curtailment of inappropriate residential, commercial, and other development in floodplains.
- Maintenance and enhancement of existing riparian vegetation to conserve and restore wildlife habitats, help control wind and bank erosion, retain soil on the land, and to reduce the amount of sediment, nutrients, and other pollutants entering waterways.
- Maintenance of grassed waterways to reduce erosion.
- Establishment of vegetation in areas of critical erosion.
- Determination of the feasibility of installing water control structures at existing culverts to retain water in drainage ditches for longer periods of time during critical runoff periods to minimize flooding in downstream areas.
- Determination of the feasibility of utilizing "on-farm storage" to control runoff through such means as natural storage areas and control structures on existing culverts.
- Prevention of overgrazing on grasslands and utilization of sound agricultural land use practices.
- Provision for strict enforcement of floodplain management programs within the subbasin.

8. The potentiality for land treatment measures (e.g., erosion control measures such as cover crops, green belts, reduction in fall tillage, etc.) needs to be thoroughly investigated.
9. The people of the subbasin need to be included in further water resource planning efforts. A public involvement program would provide more complete information on water resource problems and opportunities than is presently available.
10. More study is needed to determine the precise nature of the water supply problems and potential solutions.
11. Potentialities for floodwater storage in present drainage ditches need to be investigated.
12. The effect of drainage works on flood discharges and stages is unknown at present. It would take additional, more detailed studies to determine the extent and effect of reduced natural storage.
13. Land use within the floodplain needs to be precisely identified.
14. An adequate 100-year floodplain map needs to be developed. Also, the extent of floodplains for smaller frequency storms needs to be delineated.
15. More gauging stations need to be developed to provide hydrologic data for establishing flood frequencies and rating curves.

16. Channel cross-sections of the various streams need to be prepared for flood control planning purposes.

17. Crop distribution in the floodplain needs to be precisely identified through contact with county agents, and average annual rural damages need to be updated.

18. The irrigation potentials of the subbasin soils need to be investigated.

19. A comprehensive and up-dated inventory of recreation sites would be required to accurately identify resources.

20. Studies are needed to determine additional demand for recreational facilities, usage of existing facilities, and potential sites.

21. A regional supply and demand analysis for hunting, fishing, and other water based or related recreational pursuits is needed.

22. Whether forested acreages in the floodplain are increasing or declining needs to be precisely determined.

23. A detailed study of the objectives, goals, and programs of the many institutional entities involved in water resources planning, particularly at the local level, is needed to determine the most efficient institutional approach to the resolution of flooding problems.

24. A detailed institutional analysis of the subbasin is needed.

25. A detailed social profile of the subbasin is needed.

26. Urban damages need to be recomputed in a systematic fashion.

27. A review of secondary sources and systematic field reconnaissance is needed to identify archaeological and historical sites and to determine their eligibility for nomination to the National Register of Historic Places.

28. The causes of the fluctuations in lake levels need to be understood, and projections for new lake levels need to be developed.

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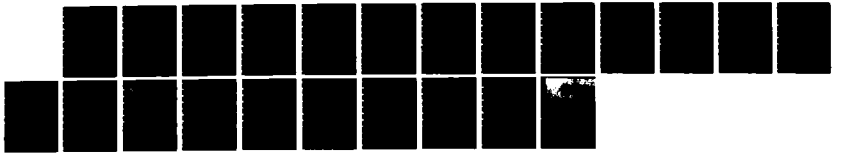

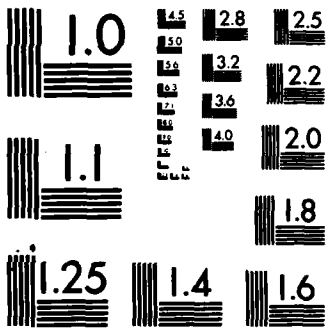


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# Appendix A
# FLOODPLAIN DELINEATION

# Appendix A
## FLOODPLAIN DELINEATION

In undertaking the task of delineation of the Devils Lake floodplain, the present study utilized all known sources to provide the best available data for generalized delineation of the subbasin at a scale of 1:250,000. Principal sources were: Corps of Engineers photomosaics of the 1979 flood (scale 1:24,000), and published secondary sources. No USGS Flood Prone Area Maps were available for the subbasin. One Federal Insurance Administrative flood map was available for the town of Rolla, but was of little significance to delineating the floodplain of the subbasin.

The primary delineation was made on the basis of the 1979 flood photography cited above. It should be recognized that coverage focused on the principal lake area in the central and southern part of the subbasin. However, the flood level is consistent with that of a 100-year flood.

Secondary sources, such as the Souris-Red-Rainy River Basins Type II Study were also utilized. The published floodplain delineation contained in the Volume 1 Study Report of The Devils Lake Basin Study was also applied. Although this area contains approximately 180,000 acres (generally more than the 100-year level), it is extremely useful for comparison and supplementation with the aerial delineation shown in Figure II.

# Appendix B
# INVENTORY OF OUTDOOR RECREATIONAL FACILITIES DEVILS LAKE SUBBASIN

## Appendix B

## INVENTORY OF OUTDOOR RECREATIONAL FACILITIES[1]
## DEVILS LAKE SUBBASIN

| Number | Name | Administration | Location | Acres | Campgrounds[2] | Playground | Athletic Field[3] | Golf Courses[4] | Boat Ramps | Picnic Tables | Beach | Pool | Trails[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Brumba NWR | Federal | Towner Co. | 1,977.0 | | | | | | | | | |
| 2 | Snyder Lake NWR | Federal | Towner Co. 16066W18 Snyder Lake | 1,550.0 | | | | | | | | | |
| 3 | Billings Lake National Wildlife Refuge | Federal | Cavalier Co. 15961W15 Billings Lake | | | | | | | | | | |
| 4 | Lac Aux Mortes NWR | Federal | Ramsey Co. 15666W03 Lake Alice | 6,108.0 | | | | | | | | | |
| 5 | Nesvig WMA | State | Benson Co. 15568W09 Leeds | 162.0 | | | | | | | | | |
| 6 | Silver Lake NWR | Federal | Benson Co. 15167W35 Church's Ferry | 3,348.0 | | | | | | | | | |
| 7 | Pelican Township WMA | State | Ramsey Co. 15466W20 Devil's Lake | 60.0 | | | | | | | | | |
| 8 | Minnewankan WMA | State | Benson Co. 15268W05 Minnewankan | 160.0 | | | | | | | | | |
| 9 | Crary WMA | State | Ramsey Co. 15362W18 Crary | 316.0 | | | | | | | | | |
| 10 | Sully's Hill NWR | Federal | Benson Co. 15265W15 Fort Totten | 1,674.0 | | | | | | | | | |

-continued-

## Appendix B (Cont'd)

## INVENTORY OF OUTDOOR RECREATIONAL FACILITIES[1]
## DEVILS LAKE SUBBASIN

| Number | Name | Administration | Location | Acres | Campgrounds[2] | Playground | Athletic Field[3] | Golf Courses[4] | Boat Ramps | Picnic Tables | Beach | Pool | Trails[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Wood Lake NWR | Federal | Benson Co. 15164W10 Tokio | 280.0 | | | | | | | | | |
| 12 | Rose Lake NWR | Federal | Nelson Co. 15261W15 | 836.0 | | | | | | | | | |
| 13 | Black Swan WMA | State | Nelson Co. 15261W26 | 855.0 | | | | | | | | | |
| 14 | Stump Lake NWR | Federal | Nelson Co. 15161W10 | 27.0 | | | | | | | | | |
| 1 | Rolla Ski View | Private | Rolitte Co. Rolla | 30.0 | | | | | | | | | |
| 2 | Snyder Lake Recreation Area | County | Towner Co. 16066W18 Snyder Lake | 129.0 | 30 | 1 | | | | 16 | 1 | | |
| 3 | Marvin Dick Goose Pit | Private | Cavalier Co. Munich | 80.0 | | | | | | | | | |
| 4 | Big Coulee Recreation Area | County | Towner Co. 16068W36 Bisbee | 352.0 | | 1 | 1 | | 1 | 5 | 1 | | |
| 5 | Iverson Dam | Private | Benson Co. 15669W24 Leeds | 50.0 | 20 | | | | | | | | |
| 6 | Leed's Park and Pool | Municipal | Benson Co. Leeds | 35.0 | 10 | | | | | 8 | | 1 | |
| 7 | Minnewankan Park | Municipal | Benson Co. Minnewankan | 45.0 | 20 | 2 | | 9 | | 4 | | 1 | |

-continued-

## Appendix B (Cont'd)

## INVENTORY OF OUTDOOR RECREATIONAL FACILITIES[1]
## DEVILS LAKE SUBBASIN

| Number | Name | Administration | Location | Acres | Campgrounds[2] | Playground | Athletic Field[3] | Golf Courses[4] | Boat Ramps | Picnic Tables | Beach | Pool | Trails[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | Highway 2 Campground | County | Ramsey Co. Devil's Lake | 27.0 | 38 | | | | | 15 | | | .5 |
| 9 | Ruger Park | Municipal | Ramsey Co. Devil's Lake | 105.0 | | | | | | | | | |
| 10 | Roosevelt Park | Municipal | Ramsey Co. Devil's Lake | 17.0 | | | 4 | | | 60 | | 1 | |
| 11 | Tumbleweed KOA | Private | Ramsey Co. Devil's Lake | 15.0 | 66 | | | | | | | 1 | |
| 12 | Zieback Recreation and Campground | County | Ramsey Co. Devil's Lake | 274.0 | 60 | 1 | 1 | | | 22 | | | 2.5 |
| 13 | Lakewood Park | Municipal | Ramsey Co. Devil's Lake | 535.0 | 67 | 1 | 2 | | 3 | 75 | 2 | | |
| 14 | Wood Lake | County | Benson Co. 15164W15 Tokio | 120.0 | 15 | | | | 1 | | | | |
| 15 | Sand Lake | Private | Benson Co. 15164W12 Tokio | 100.0 | | | | | | 2 | | 1 | |
| 16 | Reeves Lake (Elbow Lake) | Private | Benson Co. 15163W16 Tokio | 250.0 | | | | | 1 | 2 | | | |
| 17 | Old Settler's Park | County | Nelson Co. 15160W21 Lakota | 164.0 | 60 | 1 | 2 | | | 100 | | | 2 |
| (1) | Rolla Country Club | Municipal | Rolette Co. Northwest of Rolla | 40.0 | 20 | | | 9 | | | | | |

-continued-

## Appendix B (Cont'd)

## INVENTORY OF OUTDOOR RECREATIONAL FACILITIES[1]
## DEVILS LAKE SUBBASIN

| Number | Name | Administration | Location | Acres | Campgrounds[2] | Playground | Athletic Field[3] | Golf Courses[4] | Boat Ramps | Picnic Tables | Beach | Pool | Trails[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (2) | Cando Golf Course | Municipal | Towner Co. Cando | 40.0 | | | | 1 | | | | | |
| (3) | Leeds Golf Course | Private | Benson Co. Leeds | 40.0 | | | | 9 | | | | | |
| (4) | Devil's Lake Country Club | Private | Ramsey Co. Devil's Lake | 140.0 | | | | 9 | | | | | |
| (5) | Lakota Golf Course and Range | Municipal | Nelson Co. Lakota | 36.0 | | | | 1 | | | | | |

[1]Facilities included are those with 15 or more acres.

[2]Number of campsites.

[3]Number of fields.

[4]Number of holes.

[5]Number of miles.

Source: North Dakota State Parks and Recreation Department, Inventory of North Dakota Recreation Facilities, 1979, Gulf South Research Institute.

Appendix C

COMMENTS

# Appendix C

## COMMENTS

The purpose of this subbasin report was to provide an overview of the water and related resource problems and needs and to assess potential solutions. Toward this end, draft copies of this report were circulated to Federal, State, and local agencies and comments were sought.

This review resulted in complete and factual documentation. Thus, the study should serve as a building block for the timely completion of future water resource efforts within the subbasin. Further cooperative efforts are, however, needed to evaluate these tentative results and to develop potential solutions.

A distribution list and copies of the comments made with respect to the draft report are included as part of this appendix. Comments that resulted in specific modifications to the draft text are marked by an asterisk.

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB

31 December 1980

Mr. Mike Liffmann
Project Manager
Gulf South Research Institute
8000 GSRI Avenue
Baton Rouge, Louisiana 70808

Dear Mr. Liffmann:

The draft Devils Lake subbasin, North Dakota, report was distributed for review and comment. Interagency comments will be provided when they are received.

a. Inclosure 1 is the general office comments that need to be considered when preparing the final Devils Lake subbasin report and the remaining subbasin reports.

b. Inclosure 2 identifies specific office concerns that are applicable to the Devils Lake subbasin.

If you have any questions on our comments or proposed modifications, please contact us.

Sincerely,

Louis Kowalski

LOUIS KOWALSKI
Chief, Planning Branch
Engineering Division

2 Incl
As stated

GENERAL COMMENTS
DRAFT DEVILS LAKE SUBBASIN REPORT
(DECEMBER 1980)

(These comments apply to the entire report and all subsequent subbasin documents.)

1. Comments from Federal, State, and local agencies and a letter from the St. Paul District will be included in an appendix in each final subbasin and in the overall report. The format for the appendix will be:

a. Introduction - This section should stress:

(1) The importance of completing the study on time.

(2) That the purpose of the study is to advise other agencies and interests.

(3) The need for a selected review by various interests to provide complete and factual documentation.

(4) The use of the study as a building block for future water resource efforts.

(5) That cooperative efforts to evaluate results and develop solutions to remaining problems will be incorporated.

(6) A complete public involvement program when the study is finished.

b. The distribution list.

c. Copies of letters of comment.

Only comments that identify significant errors or need specific attention will be addressed in the final subbasin report. However, all comments incorporated should be identified with a marking system.

2. Care should be taken to ensure that similar data reported in the various draft reports are uniform and consistent. For example, in the climate sections temperatures are recorded in ranges, means, and averages. Also, any number presented should not be presented as more accurate than the data from which it was developed. Suggest rounding off all numbers.

3. The support information for alternatives including technical, economic, and environmental data should be provided (at least under separate cover).

4. All references by the same author and of the same year should be ranked (i.e., 1979a, 1979b, etc.) so that these references can be distinguished.

Incl 1

5. The evaluation section of each report is primarily the recommendations of the document. Generally only the alternatives which have a benefit-cost ratio greater than 1 are presented. Little attention is given to other less economically feasible alternatives that may be important in specific aspects of future flood damage reduction planning for the subbasin as well as the basin as a whole. Some of these alternatives may provide the necessary environmental or social conditions to warrant future attention. Therefore, this section should be expanded to provide the appropriate discussions.

6. The 1980 current normalized prices issued in October 1979 were revised in July 1980. Label all references to current normalized prices as "prerevision" or "postrevision" as appropriate.

7. The lack of large lakes and sizable forest tracts combined with poor water quality in existing rivers severely limits the diversity of recreation opportunities in most subbasins. Therefore, it is extremely important that alternative flood control measures be analyzed for their impacts upon those areas that do contain large lakes, sizable forest tracts, and rivers with good water quality.

SPECIFIC COMMENTS
DRAFT DEVILS LAKE SUBBASIN REPORT
(DECEMBER 1980)

* 1. Page 3 - The last paragraph states that forest acreage in the Devils Lake basin is small and mostly in Sullys Hill National Game Preserve. This conflicts with Table 3 on page 11 where it states that only about 4 percent of the total woodland acreage is publicly owned.

2. Page 4 - This is an old map of Devils Lake. The lake itself is much larger now.

* 3. Page 5, last paragraph - The first sentence doesn't make sense. The second part of the sentence doesn't follow the first part.

* 4. Page 7, Figure II - According to the title, this map is to delineate the 100-year floodplain. There is no actual outline of this on the map itself.

5. Page 8, last paragraph - This is not true. Damages were sustained in the Devils Lake subbasin in 1979. These damages would have been higher had there not been a successful flood fight and Corps emergency works.

* 6. Pages 8 and 9, Flood Damages - There are two distinct flood problems in the basin; seasonal flooding from overbank or overland flows and the potential permanent inundation of property from the continued rise of Devils Lake. Damages from increasingly higher lake elevations would be substantial and since this type of flooding is unique it warrants a more detailed discussion.

* 7. Page 9, second sentence - Rewrite as follows, "No estimate of rural damages was prepared by the St. Paul District for the 1975 or 1979 flood events." There were probably some damages, at least in 1979, since this area was included in the 1979 disaster declaration.

* 8. Page 12, paragraph 2 - The high concentrations of dissolved solids are also the result of the lack of any outlet for the system. Also the freshening of the water mentioned later in the paragraph is poorly understood and is probably only partially due to wetland drainage.

9. Page 13 - Is the comparison of the Recommended Plan and the authorized Garrison Diversion Unit Plan fair? What are the NED benefits for both plans? Also, this information applies to the entire Garrison Project. What are the effects on the Devils Lake subbasin?

* 10. Page 15, first paragraph - It is contradictory to say that the salinity level of Devils Lake has been increasing in the past years and that rising water levels decrease the saline content.

Incl 2

* 11. Page 17, Hydropower - Add to the last sentence, "but it does not appear to be economically feasible."

12. Page 17, paragraph 3 - Clarify the jurisdiction of the Devils Lake Advisory Commission. Does it only pertain to water resources?

* 12. Page 24, Land Use - The percentages given here conflict with those on pages 3 and 37. Which are correct? Also the figures on this page do not total 100 percent.

* 14. Page 25, last paragraph - Lake Cando is misspelled.

* 15. Page 32, first paragraph, first sentence - Subbasin is misspelled.

* 16. Page 35, first paragraph - Devils Lake Indian Reservation should be Fort Totten Indian Reservation.

* 17. Page 36, paragraph 2, last sentence - Change to read, "There are four sites currently listed on the National Register of Historic Places within the subbasin. Other potentially significant cultural resources are likely to be identified in the future."

18. Page 36, Recreational Resources - This should include a discussion on wetlands and woodlands. Both of these permit a variety of recreational activities, but are declining in supply and therefore are becoming increasingly valuable for recreation.

19. Page 37, Social - Give the year of the population estimates used.

20. Page 39, Cultural - This section on significant cultural resource elements should include more information from pages 36 and 37. Oral history is not the only significant cultural resource feature of the subbasin.

* 21. Page 42, first paragraph - Fee tracts is misspelled.

22. Pages 43-45 - A distinction should be made between Federal and State threatened and endangered species.

* 23. Page 46, paragraph 4 - "Other sectors have <u>accounted</u> for employment...". Should this be changed to "compensated"?

* 24. Page 48, Table 14 - Yield for sunflowers is in pounds not bushels.

25. Page 49, Table 15 - Do the equivalent average annual damages take into account the rise in the level of Devils Lake? These figures appear low. This comment also pertains to the first four paragraphs on page 50.

26. Page 50, paragraphs 2 and 3 - State what assumptions were behind the future growth rate or urban damages of 1 percent per year and the "other" agricultural damages of one-half of OBERS Series E projections.

27. Page 50, Most Probable Environmental Conditions - Include a statement on cultural resources.

28. Page 52, paragraph 2, last sentence - Is this an accurate statement? The public may perceive that there is a water resource management plan for the subbasin.

*29. Page 52, last paragraph - The number of flood control projects does not agree with Table V. What are the two to which you are referring?

*30. Page 53, first sentence - Change "...involve Indian lands." to "impact."

31. Page 53, paragraph 2 - The channel between Dry Lake and Sixmile Bay may not be plugged now. A decision has already been made.

*32. Page 54, Figure V - Some, if not all of the existing and authorized projects shown are not Corps structures.

*33. Page 56, Adequacy of Existing Measures - The area affected by flooding does not include the airport but does include commercial and industrial property as well as public property (roads etc.).

*34. Page 57, paragraph 3 - Insert "net" between "optimizes" and "benefits."

35. Page 57, paragraph 3 - Is a 100-year amortization more appropriate?

36. Page 57, Planning Objectives - The first sentence is awkward and confusing. Rewrite.

*37. Page 59, paragraph 2 - The statement "Devils Lake Watershed was not analyzed in this study, but is the subject of a subsequent study by the Corps of Engineers," is inaccurate. The study area for the Section 205 study at Devils Lake is only the city. It does not include the entire Devils Lake Watershed.

38. Pages 61 and 62 - The social, environmental, or cultural impacts of these alternatives have not been investigated, even in preliminary form, and therefore should not be considered implementable. It should be stated that these impacts have not been investigated.

39. Page 62, number 2 - There are several alternatives being discussed to prevent flood damages in the city of Devils Lake. The road raise discussed may not be the most appropriate. A levee or dam at Creel Bay is also being considered.

*40. Page 62, number 4, second sentence - What is meant by the statement "Besides producing the soil..."? Should it be "protecting"?

*41. Page 66, Table 16 - Delete the B/C ratio for the Devils Lake Outlet Alternatives. It is not valid because you are comparing average annual cost with a one time damage. The text on page 67, paragraphs 6 and 7, and page 68, paragraph 1 should be revised or deleted to reflect this.

*42. Page 68 - The impact assessment promises that the rationale for the ratings will be presented but no rationales are discussed. The ratings are merely reiterated verbally.

43. Page 68, Devils Lake Outlet Channels I, II and III - These may not be maximally beneficial if downstream effects are considered. Water quality might improve with time until an equilibrium is reached, therefore, it will perhaps not be moderately adverse over a period of time.

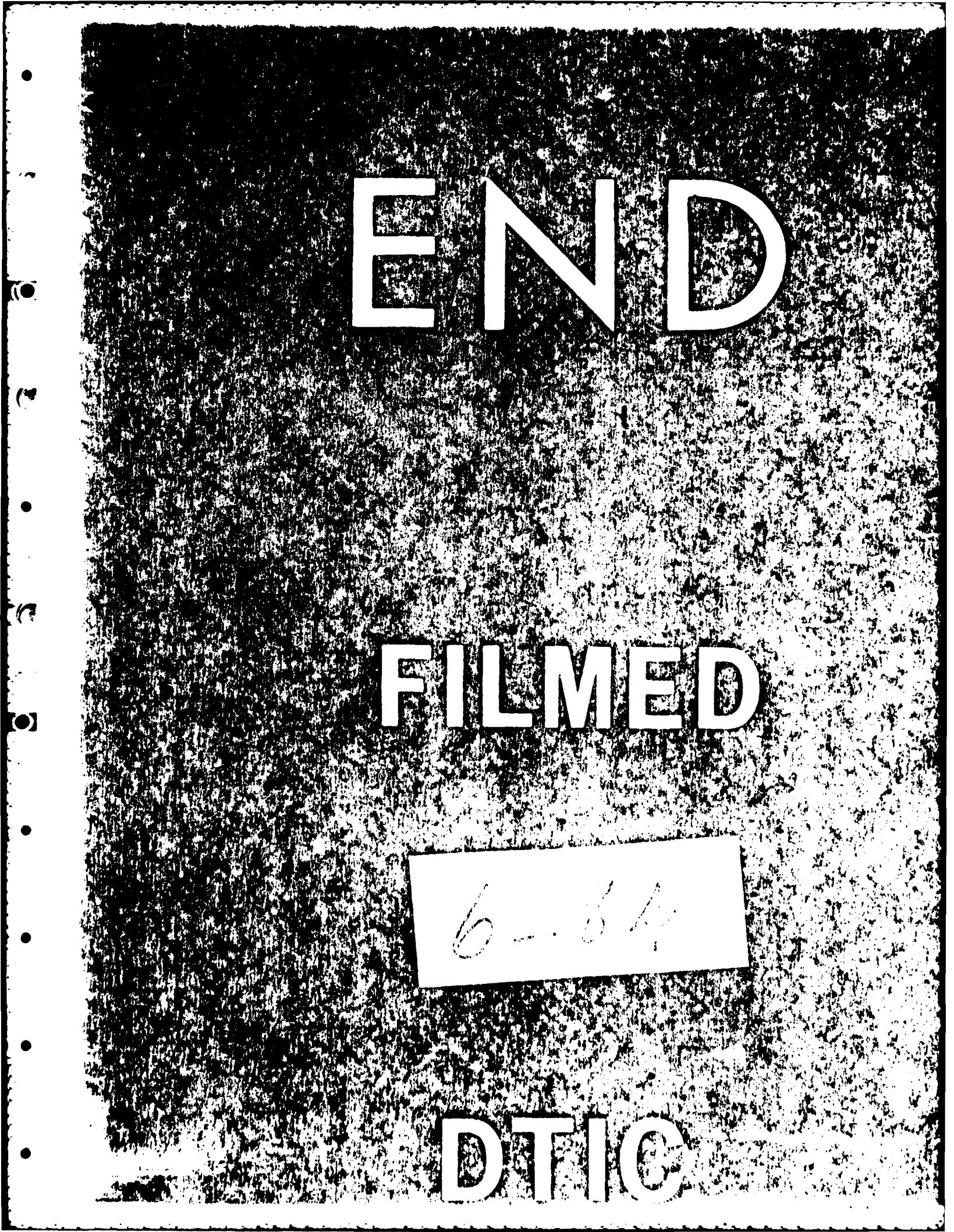
*44. Page 69, Table 17, Alternative 10 - Raise Dump Road. Most of the benefits for the Devils Lake outlet channel come from alleviating flood problems at the city of Devils Lake. Therefore, alternative 10 should also be considered MaB for economics, NKL for Land Use and MiB for Water Quality. Otherwise the text should be revised.

*45. Page 71, first paragraph - The numbers are inconsistent. In the first sentence, "Twelve of the 13 alternatives...," contradicts "The two...," in the next sentence.

*46. Page 71 - The statement is made that "Alternatives 11, 12, and 13... maximize economic benefits for the subbasin." This statement may indicate a misunderstanding about these alternatives. The three would not be chosen together; rather, one of the three would be chosen to alleviate flooding from high water levels on Devils Lake. It has been estimated that any one of the three could prevent $3,000,000 in damages if lake levels were to reach 1435 feet, but no benefits beyond $3,000,000 would be achieved because of implementation of two or three of the alternatives. Since Alternative 12 is least costly and since benefits from each of the three would be equal, Alternative 12 would maximize economic benefits and Alternatives 11 or 13 would not.

*47. Page 74 - Add the following under Additional Study Needs. 28. The causes of the fluctuations in lake levels need to be understood and projections for future lake levels need to be developed.

48. Bibliography - References in the text cited as U.S. Army Corps of Engineers are not consistent with reference cited in the Bibliography.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